Report of the South African Association for the Advancement of Science.

Stellenbosch, 1917.

REPORT

OF THE

FIFTEENTH ANNUAL MEETING OF THE

SOUTH AFRICAN ASSOCIATION

FOR THE ADVANCEMENT OF SCIENCE.

ERRATA.

Page 377, line 11: for "Frances" read "Francis."

Page 379, line 13 from bottom: for "when" read "whence."

Page 382, line 4: for "men" read "many."
line 9 from bottom: for "each" read "the."

Page 383, line 23: for "a compartment" read "the compartment."

Plate 12, opposite page 425: for *Metruastra pithyocnysa*" read "*Metanastria pithyocampa.*"

CAPE TOWN:
PUBLISHED BY THE ASSOCIATION.

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STELLENBOSCH,

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JULY 2—7.

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OFFICERS AND COUNCIL, 1916-1917.

HONORARY PRESIDENT.

HIS MAJESTY THE KING.

PRESIDENT.

Professor J. ORR, B.Sc., M.I.C.E., M.I.Mech.E.

EX-PRESIDENT.

Professor L. CRAWFORD, M.A., D.Sc., F.R.S.E.

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Professor W. N. Roseveare, M.A.
Prof. E. H. L. Schwarz, A.R.C.S. F.G.S.
H. E. Wood, M.Sc., F.R.Met.S.

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J. A. Foote, F.G.S., F.E.I.S., Commercial High School, Plein Street, Johannesburg.

HON. GENERAL TREASURER.

A. Walsh, P.O. Box 39, Cape Town.

ASSISTANT GENERAL SECRETARY.

H. Tucker, Cape of Good Hope Savings Bank Buildings, St. George's Street, Cape Town. P.O. Box 1497. (Telegraphic Address: "Scientific.")

ORDINARY MEMBERS OF COUNCIL.

I. CAPE PROVINCE.

Cape Peninsula.

A. J. Anderson, M.A., M.B., D.P.H., M.R.C.S.
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W. A. Caldecott, B.A., D.Sc., F.C.S.
P. Cazalet.
H. Fielden Briggs, M.D., L.D.S., F.C.S.

Pretoria.

I. B. Pole Evans, M.A., B.Sc., F.L.S.
F. E. Kanthack, M.I.C.E., M.I.M.E.
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Prof. H. A. Wager, A.R.C.S.

Potchefstroom.

E. Holmes Smith, B.Sc.

III. ORANGE FREE STATE.

Bloemfontein.

Prof. T. M. Forsyth, M.A., D.Phil.
Prof. M. M. Rindl, Ing.D.

IV. NATAL.

Durban.

M. S. Evans, C.M.G., F.Z.S.

Maritzburg.

R. A. Buntine, M.L.A., M.B., B.Ch.
Prof. E. Warren, D.Sc.

V. RHODESIA.

Bulawayo.

Rev. S. S. Dornan, M.A. F.G.S.

VI. MOZAMBIQUE.

S. Seruya.

TRUSTEES.

Endowment Fund.

J. W. Jagger, F.S.S., M.L.A.
W. Runciman, M.L.A.
A. D. R. Tugwell.

S.A. Medal Fund.

W. E. Gurney.
C. Murray, M.A.
W. Thomson, M.A., B.Sc., LL.D., F.R.S.E.

CONSTITUTION

OF THE

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

[*As amended at the Fourteenth Annual Meeting at Maritzburg*, 1916.]

I.—OBJECTS.

The objects of the Association are:—To give a stronger impulse and a more systematic direction to scientific enquiry; to promote the intercourse of societies and individuals interested in Science in different parts of South Africa; to obtain a more general attention to the objects of pure and applied Science, and the removal of any disadvantages of a public kind which may impede its progress.

II.—MEMBERSHIP.

(*a*) All persons interested in the objects of the Association are eligible for Membership.

(*b*) Institutions, Societies, Government Departments and Public Bodies are eligible as "Institutional Members."

(*c*) The Association shall consist of (a) Life Members, (b) Ordinary Members (both of whom shall be included under the term "Members"), (c) Institutional Members, and (d) Temporary Members, elected for a session, hereinafter called "Associates."

(*d*) Members, Institutional Members, and Associates shall be elected directly by the Council, but Associates may also be elected by Local Committees. Members may also be elected by a majority of the Members of Council resident in that centre at which the next ensuing session is to be held.

(*e*) The Council shall have the power, by a two-thirds vote, to remove the name of a member of any class whose Membership is no longer desirable in the interests of the Association.

III.—PRIVILEGES OF MEMBERS AND ASSOCIATES.

(*a*) Life Members shall be eligible for all offices of the Association, and shall receive gratuitously all ordinary publications issued by the Association.

(*b*) Ordinary Members shall be eligible for all offices of the Association, and shall receive *gratuitously* all ordinary publications issued by the Association during the year of their admission, and during the years in which they continue to pay, *without intermission,* their Annual Subscription.

(*c*) Institutional Members shall receive *gratuitously* all ordinary publications of the Association on the same conditions as ordinary members; and each Institutional Member shall be entitled to send one representative to the Annual Session of the Association.

(*d*) Associates are eligible to serve on the Reception Committee, but are not eligible to hold any other office, and they are not entitled to receive gratuitously the publications of the Association.

(*e*) Members and Institutional Members may purchase from the Association (for the purpose of completing their sets) any of the Annual Reports of the Association, at a price to be fixed upon by the Council.

IV.—SUBSCRIPTIONS.

(*a*) Every Life Member shall pay, on admission as such, the sum of Ten Pounds.

(*b*) Ordinary and Institutional Members shall pay, on election, an Annual Subscription of One Pound. Subsequent Annual Subscriptions shall be payable on the first day of July in each year.

(*c*) An Ordinary Member may at any time become a Life Member by one payment of Ten Pounds in lieu of future Annual Subscriptions. An Ordinary Member may, after ten years, provided that his subscriptions have been paid regularly without intermission, become a Life Member by one payment of Five Pounds in lieu of future Annual Subscriptions.

(*d*) The Subscription for Associates for a Session shall be Ten Shillings.

V.—MEETINGS.

The Association shall meet in Session Annually. The place of meeting shall be appointed by the Council as far in advance as possible, and the arrangements for it shall be entrusted to the Local Committee, in conjunction with the Council.

VI.—COUNCIL.

(*a*) The Management of the affairs of the Association shall be entrusted to a Council, five to form a quorum.

(*b*) The Council shall consist of the President, Retiring President, four Vice-Presidents, two General Secretaries, the General Treasurer, and the Editor of the publications of the Association, together with one Member of Council for every twenty Members of the Association.

(*c*) The President, Vice-Presidents, General Secretaries, General Treasurer, and the Editor of the publications of the Association shall be nominated at a meeting of Council not later than two months previous to the Annual Session, and shall be elected at the Annual General Meeting.

(*d*) Ordinary Members of Council to represent centres having more than 20 Members shall, not later than one month prior to the Annual Session of the Association, be elected by each such Centre, in the proportion of one representative for every twenty Members. The Annual General Meeting shall elect other Ordinary Members of Council, in number so as to give, together

with the Members of Council already elected by the Centres, in all, one Member of Council for every twenty Members of the Association.

(*e*) The Council shall have the power to co-opt Members, not exceeding five in number, from among the Members of the Association resident in that Centre at which the next ensuing Session is to be held.

(*f*) In the event of a vacancy occurring in the Council, or among the Officers of the Association, in the intervals between the Annual Sessions, or in the event of the Annual Meeting leaving vacancies, the Council shall have the power to fill such vacancies.

(*g*) During any Session of the Association the Council shall meet at least twice, and the Council shall meet at least six times during the year, in addition to such Meetings as may be necessary during the Annual Session of the Association.

(*h*) The Council shall have the power to pay for the services of Assistant General Secretaries, for such clerical assistance as it may consider necessary, and for such assistance as may be needed for the publication of the Association Report or Journal.

(*i*) The Council shall have power to frame Bye-laws to facilitate the practical working of the Association, so long as these Bye-laws are not at variance with the Constitution.

VII.—LOCAL AND RECEPTION COMMITTEES.

(*a*) A Local Committee shall be constituted for the Centre at which the Annual Session is to be held, and shall consist of the Members of the Council resident in that Centre, with such other Members of the Association as the said Members of Council may elect.

(*b*) The Local Committee shall form a Reception Committee to assist in making arrangements for the reception and entertainment of visitors. Such Reception Committee may include persons not necessarily Members or Associates of the Association.*

(*c*) The Local Committee shall be responsible for all expenses in connection with the Annual Session of the Association

VIII.—HEADQUARTERS.

The Headquarters of the Association shall be in Cape Town.

* The Reception Committee should make arrangements to provide :—

(1) A large hall for the delivery of the Presidential Address and evening lectures.

(2) A large room to be used as a Reception Room for members and others, at which all information regarding the Association can be obtained, and which shall have attached to it two Secretaries' Offices, a Writing Room for members and others, a Smoking Room, and Ladies' Room.

(3) Four rooms, each capable of accommodating about 30 or 40 people, to be used as Sectional Meeting Rooms, and, if possible, to have rooms attached, or in close proximity, for the purpose of holding meetings of Sectional Committees.

(4) Other requirements, such as office furniture, blackboards, window blinds to darken sectional meeting rooms for Lantern lectures, notice boards, etc.

IX.—FINANCE.

(*a*) The Financial Year shall end on the 31st of May.

(*b*) All sums received for Life Subscriptions and for Entrance Fees shall be invested in the names of three Trustees appointed by the Council, and only the interest arising from such investment shall be applied to the uses of the Association, except by resolution of a General Meeting; provided that any composition fee as a Life Member paid over to the Trustees of the Endowment Fund after the 30th day of May, 1914, may, upon the death of such Member, be repaid by the Trustees to the General Account of the Association, if the Council shall so decide.

(*c*) The Local Committee of the Centre in which the next ensuing Session is to be held shall have the power to expend money collected, or otherwise obtained in that Centre, other than the subscriptions of Members. Such disbursements shall be audited, and the financial statement and the surplus funds forwarded to the General Treasurer within one month after the Annual Session.

(*d*) All cheques shall be signed by the General Treasurer and a General Secretary, or by such other person or persons as may be authorised by the Council.

(*e*) Whenever the balance in the hands of the Treasurer shall exceed the sum requisite for the probable or current expenses of the Association, the Council shall invest the excess in the names of the Trustees.

(*f*) On the request of the majority of the Members of Council of any Centre in which two or more Members of Council reside, the Council shall empower the local Members of Council in that Centre to expend sums not exceeding in the aggregate 10 per centum of the amount of Annual Subscriptions raised in that Centre.

(*g*) The whole of the accounts of the Association, *i.e.*, the local as well as the general accounts, shall be audited annually by an auditor appointed by the Council, and the balance-sheet shall be submitted to the Council at the first meeting thereafter, and be printed in the Annual Report of the Association.

X.—SECTIONS OF THE ASSOCIATION.

The Scientific Work of the Association shall be transacted under such sections as shall be constituted from time to time by the Council, and the constitution of such Sections shall be published in the Journal.

The Sections shall deal with the following Sciences and such others as the Council may add thereto from time to time:—Agriculture; Anthropology and Ethnology; Archæology; Architecture; Anatomy; Astronomy; Bacteriology; Botany; Chemistry; Education; Engineering; Eugenics; Geodesy and Surveying; Geography, Geology and Mineralogy; Irrigation; Mathematics; Mental Science; Meteorology; Philology; Physics; Physiology;

Political Economy; Sanitary Science; Sociology; Statistics, Zoology.

XI.—RESEARCH COMMITTEES.

(*a*) Grants may be made by the Association to Committees or to individuals for the promotion of Scientific research.

(*b*) Every proposal for special research, or for a grant of money in aid of special research shall primarily be considered by the Sectional Committee dealing with the science specially concerned, and if such proposal be approved, shall be referred to the Council.

(*c*) A Sectional Committee may recommend to Council the appointment of a Research Committee, composed of Members of the Association, to conduct research or to administer a grant in aid of research.

(*d*) In recommending the appointment of Research Committees, the Sectional Committee shall specifically name all Members of such Committees; and one of them, who has notified his willingness to accept the office, shall be appointed to act as Secretary. The number of Members appointed to serve on a Research Committee shall be as small as is consistent with its efficient working.

(*e*) All recommendations adopted by Sectional Committees shall be forwarded without delay to the Council for consideration and decision.

(*f*) Research Committees shall be appointed for one year only, but if the work of a Research Committee cannot be completed in that year, application may be made, through a Sectional Committee, at the next Annual Session for re-appointment, with or without a grant—or a further grant—of money.

(*g*) Every Research Committee, and every individual, to whom a grant had been made, shall present to the following Annual Meeting a report of the progress which has been made, together with a statement of the sums which have been expended. Any balance shall be returned to the General Treasurer.

(*h*) In each Research Committee, the Secretary thereof shall be the only person entitled to call on the Treasurer for such portions of the sums granted as may from time to time be required.

XII.—SPECIAL COMMITTEES.

The Council shall have power to appoint Special Committees to deal with such subjects as it may approve, to draft regulations for any such Committees, and to vote money to assist the Committees in their work.

XIII.—SECTIONAL COMMITTEES.

(*a*) The Sectional Committees shall consist of a President, two Vice-Presidents, two or more Secretaries, and such other persons as the Council may consider necessary, who shall be elected by the Council. Of the Secretaries, one shall act as Recorder of the Section, and at least one shall be resident in the Centre where the Annual Session is to be held.

(*b*) From the time of their election, which shall take place as soon as possible after the Session of the Association, they shall form themselves into an organising Committee for the purpose of obtaining information upon Papers likely to be submitted to the Sections, and for the general furtherance of the work of the Sectional Committees.

(*c*) The Sectional Committees shall have power to add to their number from among the Members of the Association.

(*d*) The Committees of the several Sections shall determine the acceptance of Papers before the beginning of the Session, keeping the General Secretaries informed from time to time of their work. It is therefore desirable, in order to give an opportunity to the Committees of doing justice to the several communications, that each author should prepare an Abstract of his Paper, and he should send it, together with the original Paper, to the Secretary of the Session before which it is to be read, so that it may reach him at least a fortnight before the Session.

(*e*) Members may communicate to the Sections the Papers of non-members.

(*f*) The Author of any Paper is at liberty to reserve his right of property therein.

(*g*) The Sectional Committees shall meet not later than the first day of the Session in the Rooms of their respective Sections, and prepare the programme for their Sections and forward the same to the General Secretaries for publication.

(*h*) The Council cannot guarantee the insertion of any Report, Paper or Abstract in the Annual Volume unless it be handed to the Secretary before the conclusion of the Session.

(*i*) The Sectional Committees shall report to the Council what Reports, Papers or Abstracts it is thought advisable to print, but the final decision shall rest with the Council.

XIV.—ALTERATION TO RULES.

Any proposed alteration of the Rules—

a. Shall be intimated to the Council three months before the next Session of the Association.

b. Shall be duly considered by the Council and communicated by Circular to the Members of the Association for their consideration, and dealt with at the said Session of the Association.

During the interval between two Annual Sessions of the Association, any alterations proposed to be made in the Rules shall be valid if agreed to by two-thirds of the Members of Council. Such alteration of Rules shall not be permanently incorporated in the Constitution until approved by the next Annual Meeting.

XV.—VOTING.

In voting for Members of Council, or on questions connected with Alterations to Rules, absent Members may record their vote in writing.

RULES FOR THE AWARD OF MEDALS.

A. The South Africa Medal.

I.—Constitution of Committee.

(*a*) The Council of the South African Association for the Advancement of Science shall, annually and within three months after the close of the Annual Session, elect a Committee to be called "the South Africa Medal Committee" on which, as far as possible, every Section of the Association and each Province of South Africa shall have fair representation.

(*b*) This Committee shall consist of eight Members elected from amongst Council Members, together with four other Members, selected from amongst Members of the Association who are not on the Council.

(*c*) Each new Committee shall retain not less than four members who have served on the previous Committee.

(*d*) The Chairman of the Committee shall be appointed annually by the Council from amongst its Members.

(*e*) Any casual vacancy in the Committee shall be filled by the Council.

II.—Duties.

(*a*) The duties of the Committee shall be to administer the Income of the Fund and to award the Medal, raised in commemoration of the visit of the British Association to South Africa in 1905, in accordance with the resolution of its Council.

(*b*) This resolution reads as follows:—

(1) That, in accordance with the wishes of subscribers, the South Africa Medal Fund be invested in the names of the Trustees appointed by the South African Association for the Advancenent of Science.

(2) That the Dies for the Medal be transferred to the Association, to which, in its corporate capacity, the administration of the Fund and the award of the Medal shall be, and is hereby, entrusted, under the conditions specified in the Report to the Medal Committee.

(*c*) The terms of conveyance are as follows:—

(1) That the Fund be devoted to the preparation of a Die for a Medal, to be struck in Bronze, 2½ inches in diameter; and that the balance be invested and the annual income held in trust.

(2) That the Medal and income of the Fund be awarded by the South African Association for the Advancement of Science for achievement and promise in scientific research in South Africa.

(3) That, so far as circumstances admit, the award be made annually.

(*d*) The British Association has expressed a desire that the award shall be made only to those persons whose Scientific work is likely to be usefully continued by them in the future.

The South Africa Medal.

III.—Awards.

(*a*) Any individual engaged in Scientific research in South Africa shall be eligible to receive the award.

(*b*) The Medal and the available balance of one year's income from the Fund shall be awarded to one candidate only in each year (save in the case of joint research); to any candidate once only; and to no member of the Medal Committee.

(*c*) Nominations for the recipient of the award may be made by any member of the South African Association for the Advancement of Science, and shall be submitted to the Medal Committee not later than six months after the close of the Annual Session.

(*d*) The Medal Committee shall recommend the recipient of the award to the Council, provided the recommendation is carried by the vote of at least a majority of three-fourths of its Members, voting verbally or by letter, and submitted to the Council at least one month prior to the Annual Session for confirmation.

(*e*) The award shall be made by the full Council of the South African Association for the Advancement of Science after considering the recommendations of the Medal Committee, provided it is carried by the vote of a majority of its Members, given in writing or verbally.

(*f*) The Council shall have the right to withhold the award in any year, and to devote the funds rendered available thereby, in a subsequent award or awards, provided the stipulation contained in the second term of conveyance of the British Association is adhered to.

(*g*) No alteration shall be made in these Rules except under the condition specified in Chapter XIV. of the Association's Constitution, reading:—

Any proposed alteration of the Rules—

a. Shall be intimated to the Council three months before the next Session of the Association.

b. Shall be duly considered by the Council, and be communicated by circular to the Members of the Association for their consideration, and dealt with at the said Session of the Association.

(*h*) Should a Member of the Medal Committee accept nomination for the Award or be absent from South Africa at any time within four months before the commencement of the ensuing Annual Session, he will *ipso facto* forfeit his seat on the Committee.

B. The Goold-Adams Medals.

(*a*) The Medals shall be awarded on the joint results of the Matriculation and University Senior Certificate Examinations of the University of the Cape of Good Hope.

(*b*) One Medal shall be awarded to the student who has taken the highest place in each of the seven Science subjects; (1) Physics, (2) Chemistry, (3) Elementary Physical Science, (4) Botany, (5) Zoology, (6) Elementary Natural Science, and (7) Mathematics, as set forth in the University Matriculation Examination and the University Senior Certificate Examination; and who is not over the prescribed age for Exhibitions at the Matriculation Examination.

(*c*) The standard of marks shall be not less than 65 per cent. of the maximum.

(*d*) The Medals shall be struck in bronze.

BYE-LAWS

I. *Bye-laws under which the O.F.S. Philosophical Society was incorporated, from 1st July, 1914, with the South African Association for the Advancement of Science, with the designation of "The Orange Free State Branch" of the Association.*

1. The O.F.S. Philosophical Society to be incorporated with the South African Association for the Advancement of Science, this being the only course of procedure open under the existing Constitution.

2. The title of the Society so incorporated to be "The Orange Free State Branch of the South African Association for the Advancement of Science."

3. All members of the South African Association for the Advancement of Science resident in the Orange Free State will, for purposes of these bye-laws, be considered members of the Orange Free State Branch of the Association.

4. The local Committee of the Branch to consist of the Council members of the Association for the Orange Free State, together with such additional members as the Branch may elect to serve on its local Committee.

5. Subscription notices to members of the Branch to be circulated from the Head Office of the Association in Capetown, and subscriptions to be paid to the General Treasurer of the Association at Capetown, 10 per cent. thereof being remitted to the Orange Free State Branch for local expenses. Subscriptions of £1 per annum to entitle to membership of the Association as a whole, as well as of the Orange Free State Branch.

6. All members at present on the books of the Orange Free State Philosophical Society to be entitled to become members of the Association, to receive its Journal, and to enjoy the full privileges of membership, as soon as their subscription of £1 for the financial year 1914-15 shall have been paid.

7. Papers read before the Orange Free State Branch may either (1) be printed by title, abstract, or *in extenso*, in the Journal of the Association for the current year, after reference to the Presidents of the respective Sectional Committees, or (2) be read at the next Annual Session of the Association (provided that they have not been previously published in abstract or *in extenso*), and thereafter printed in the Association's Journal, subject to the ordinary conditions.

II. Bye-laws for the guidance of Sectional Officers.

1. The attention of all Sectional Officers is directed to Chapter XIII. of the Association's Constitution, relating to the Sectional Committees and their functions.

2. The President and Recorder (or Secretary) of a Section shall have power during the Annual Session to act on behalf of the Section in any matter of urgency which cannot be brought before the consideration of the whole Sectional Committee; and they shall report such action to the next meeting of the Sectional Committee.

3. The President of the Section, or, in his absence, one of the two Vice-Presidents, shall preside at all meetings of the Section or of the Sectional Committee.

4. The President of the Section is expected to prepare a Presidential Address, which shall be delivered during the Annual Session.

5. Prior to the commencement of the Session, the Recorder of each Section shall prepare a list of all papers notified to be read during the Session, and shall also keep the Assistant Secretary of the Association informed of the titles and authors of all such papers. The Assistant Secretary shall, on his part, keep the Recorder informed of all papers that may be notified to him direct.

6. When a proposal is made for the reading of a paper at a joint meeting of Sections, the President, Recorder and Secretary of each Section shall *ex officio* attend a meeting convened by a General Secretary to consider the same.

7. During the continuance of the Annual Session, the Local Secretary of each Section shall be responsible for the punctual transmission to the Assistant Secretary of the daily programme of his Section for early publication, and of any other recommendations adopted by the Sectional Committee; and shall, at the close of the Session, furnish the Assistant Secretary with a list, showing which of the papers notified for reading before the Section have been so read, and which have been taken as read, and giving the dates in either case. He shall, at the same time, indicate the recommendations of the Sectional Committee with respect to each paper, *i.e.*, whether it should be printed in full, or in abstract, or by title only.

8. Each Sectional Committee shall cause to be prepared a record of the discussion on each paper read at its meetings; and

such record shall be attached to the paper and handed in with the same in terms of Clause 11 of these instructions.

9. Each Sectional Committee shall, during the continuance of the Annual Session, meet daily, unless otherwise determined, to complete the arrangements for the next day.

10. In deciding on any recommendation regarding the printing of or otherwise of a paper submitted to it, the Sectional Committee shall consider only the merits of the paper, and not the financial condition of the Association.

11. The Local Secretary of each Section shall, at the close of each day, collect the papers that have been read and hand them to the Assistant Secretary, together with a note explaining the cause of absence of any paper not so handed over.

12. Sectional Officers shall do their utmost to ensure punctual commencement and termination of the Section's daily proceedings; and, in drafting the programme for the next day, the Committee shall endeavour to allot a specified time to the reading and discussion of each paper, in order to prevent other Sections or the Association as a whole being inconvenienced in consequence of delays.

III.—*Bye-Laws for the Affiliation of Scientific and Kindred Societies.*

Philosophical and Scientific Societies, and other Associations of a kindred character may, on application to, and with the approval of the Council, affiliate with the South African Association for the Advancement of Science on the following conditions:—

1. That as a Society can only be affiliated on the approval of the Council, no minimum of membership of such Society need be specified.

2. That each Society shall pay the Association a minimum fee of £5 for a strength of 50 members or less, and a further £1 for each additional 10 or portion of 10 members.

3. That such Society shall be entitled to one copy of the SOUTH AFRICAN JOURNAL OF SCIENCE for each £1 paid to the Association.

4. That such Society may, if it has a strength of 50 members, be represented on the Council of the Association by its President or such other member as may be nominated for the purpose.

5. That all members of affiliated Societies may join the Association as ordinary members, with full privileges, at a reduced annual subscription of 15s

6. That affiliated Societies shall be asked to take into consideration the admission of members of the Association into their Societies at a reduced subscription.

7. That papers contributed to affiliated Societies may, on recommendation of both their own Council and that of the Association, be printed in the Association's JOURNAL OF SCIENCE, after which the authors shall be entitled to reprints on the usual terms.

Table showing the Places and Dates of Meeting of the South African Association, with Presidents, Vice-Presidents, and Local Secretaries, from its Foundation.

PRESIDENTS.	VICE-PRESIDENTS.	LOCAL SECRETARIES.
Sir DAVID GILL, K.C.B., LL.D., F.R.S., F.R.S.E.— CAPE TOWN, April 27, 1903.	S. J. Jennings, M.Amer.I.M.E., M.I.M.E. Sir Charles Metcalfe, Bart, M.I.C.E. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E. Gardner F. Williams, M.A.	J. D. F. Gilchrist, M.A., D.Sc., Ph.D., F.L.S.
Sir CHARLES METCALFE, Bart., M.I.C.E. JOHANNESBURG, April 4, 1904.	J. Fletcher, A.M.I.C.E. S. J. Jennings, M.Amer.I.M.E., M.I.M.E. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E. Gardner F. Williams, M.A.	T. Reunert, M.I.C.E., M.I.M.E.
THEODORE REUNERT, M.I.C.E., M.I.M.E. JOHANNESBURG, August 28, 1905.	J. Fletcher, A.M.I.C.E. S. J. Jennings, M.Amer.I.M.E., M.I.M.E. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E. Gardner F. Williams, M.A.	W. Cullen.
GARDNER F. WILLIAMS, M.A. KIMBERLEY, July 9, 1906.	J. Burtt-Davy, F.L.S., F.R.G.S. James Hyslop, D.S.O., M.B., C.M. S. J. Jennings M.Amer.I.M.E., M.I.M.E., M.I.M.M. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E.	W. M. Wallace, A.R.C.S., A.M.I.C.E.
JAMES HYSLOP, D.S.O., M.B., C.M. DURBAN, July 16, 1907.	J. Burtt-Davy, F.L.S., F.R.G.S. S. J. Jennings, M.Amer.I.M.E., M.I.M.E., M.I.M.M. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E. Prof. S. Schönland, M.A., Ph.D., F.L.S., C.M.Z.S.	C. W. P. Douglas de Fenzi.
H.E. the Hon. Sir WALTER HELY-HUTCHINSON, G.C.M.G., LL.D. GRAHAMSTOWN, July 6, 1908.	Prof. J. C. Beattie, D.Sc., F.R.S.E. S. J. Jennings, M.Amer.I.M.E., M.I.M.E., M.I.M.M. Prof. S. Schönland, M.A., Ph.D., F.L.S., C.M.Z.S. Ernest Williams, A.M.I.C.E., M.I.M.M.	Prof. J. E. Duerden, M.Sc., Ph.D., A.R.C.S. W. Hammond Tooke.
H.E. Sir HAMILTON GOOLD-ADAMS, G.C.M.G., C.B. BLOEMFONTEIN, September 27, 1909.	J. Burtt-Davy, F.L.S., F.R.G.S. Hugh Gunn, M.A. R. Marloth, M.A., Ph.D. Prof. S. Schönland, M.A., Ph.D., F.L.S., C.M.Z.S.	Prof. G. Potts, M.Sc., Ph.D. A. Stead, B.Sc., F.C.S.

PRESIDENTS.	VICE-PRESIDENTS	LOCAL SECRETARIES
THOMAS MUIR, C.M.G., M.A., LL.D., F.R.S., F.R.S.E. CAPE TOWN, October 31, 1910.	W. Cullen Hugh Gunn, M.A. Prof. P. D. Hahn, M.A., Ph.D. J. M. P. Muirhead, F.S.S., F.R.S.E.	C. F. Juritz, M.A., D.Sc., F.I.C.
Professor PAUL DANIEL HAHN, M.A., Ph.D. BULAWAYO, July 3, 1911.	Prof. L. Crawford, M.A., D.Sc., F.R.S.E. C. W. Howard, B.A., F.E.S. A. J. C. Molyneux, F.G.S., F.R.G.S. A. Theiler, C.M.G.	G. N. Blomehead.
ARNOLD THEILER, C.M.G., D.Sc. PORT ELIZABETH, July 1, 1912.	Prof. L. Crawford, M.A., D.Sc., F.R.S.E. J. Moir, M.A., D.Sc., F.C.S. A. J. C. Molyneux, F.G.S., F.R.G.S. W. Arnott	E. G. Bryant, B.A., B.Sc.
ALEXANDER W. ROBERTS, D.Sc., F.R.A.S., F.R.S.E. LOURENCO MARQUES, July 7, 1913.	Prof. L. Crawford, M.A., D.Sc., F.R.S.E. R. T. A. Innes, F.R.A.S., F.R.S.E. A. J. C. Molyneux, F.G.S., F.R.G.S. J. H. von Hafe	H. E. Wood, M.Sc., F.R.Met.S.
Professor RUDOLF MARLOTH, M.A., Ph.D. KIMBERLEY, July 6, 1914.	Prof. L. Crawford, M.A., D.Sc., F.R.S.E. S. Evans W. Johnson, L.R.C.P., L.R.C.S. A. F. Williams, B.Sc.	A. F. Williams, B.Sc. F. Harrison.
ROBERT T. A. INNES, F.R.A.S., F.R.S.E. PRETORIA, July 5, 1915.	Prof. L. Crawford, M.A., D.Sc., F.R.S.E. G. W. Herdman, M.A., M.I.C.E. Sir Arnold Theiler, K.C.M.G., D.Sc. A. H. Watkins, M.D., M.R.C.S., M.L.A.	E. Hope Jones.
Professor LAWRENCE CRAWFORD, M.A., D.Sc., F.R.S.E. MARITZBURG, July 3, 1916.	Rev. W. Flint, D.D. Lieut.-Col. J. Hyslop, D.S.O., M.B., C.M. Prof. J. Orr, B.Sc., M.I.C.E. Sir A. Theiler, K.C.M.G., D.Sc.	Prof. W. N. Roseveare, M.A.
Professor JOHN ORR, B.Sc., M.I.C.E., M.I.Mech.E., STELLENBOSCH, July 2, 1917.	A. H. Reid, F.R.I.B.A., F.R.San.I. Prof. W. N. Roseveare, M.A. Prof. E. H. L. Schwarz, A.R.C.S., F.G.S. H. E. Wood, M.Sc., F.R.Met.S.	Prof. B. de St. J. van der Riet, M.A., Ph.D.

Presidents and Secretaries of the Sections of the Association.

Date and Place.	Presidents.	Secretaries.
SECTION A.—ASTRONOMY, CHEMISTRY, MATHEMATICS, METEOROLOGY AND PHYSICS.		
1903. Cape Town ..	Prof. P. D. Hahn, M.A., Ph.D.	Prof. L. Crawford.
1904. Johannesburg*	J. R. Williams, M.I.M.M., M.Amer.I.M.E.	W. Cullen, R. T. A. Innes.
1906. Kimberley ..	J. R. Sutton, M.A.	W. Gasson, A. H. J. Bourne.
1907. Natal†	E. N. Neville, F.R.S., F.R.A.S., F.C.S.	D. P. Reid, G. S. Bishop.
1908. Grahamstown	A. W. Roberts, D.Sc., F.R.A.S., F.R.S.E.	D. Williams, G. S. Bishop.
ASTRONOMY, MATHEMATICS, PHYSICS, METEOROLOGY, GEODESY, SURVEYING, ENGINEERING, ARCHITECTURE AND GEOGRAPHY.		
1909. Bloemfontein	Prof. W. A. D. Rudge, M.A.	H. B. Austin, F. Masey.
1910. Cape Town ‡	Prof. J. C. Beattie, D.Sc., F.R.S.E.	A. H. Reid, F. Flowers.
1911. Bulawayo ..	Rev. E. Goetz, S.J., M.A., F.R.A.S.	A. H. Reid, Rev. S. S. Dornan.
1912. Port Elizabeth	H. J. Holder, M.I.E.E.	A. H. Reid.
1913. Lourenço Marques	J. H. von Hafe.	Prof. J. Orr, J. Vaz Gomes.
1914. Kimberley ..	Prof. A. Ogg, M.A., B.Sc., Ph.D.	Prof. A. Brown, A. E. H. Dinham-Peren.
1915. Pretoria ..	F. E. Kanthack, M.I.C.E., M.I.M.E.	Prof. A. Brown, J. L. Soutter.
1916. Maritzburg ..	Prof. J. Orr, B.Sc., M.I.C.E.	Prof. A. Brown, P. Mesham.
1917. Stellenbosch ..	Prof. W. N. Roseveare, M.A.	Prof. A. Brown, L. Simons.
SECTION B.—ANTHROPOLOGY, ETHNOLOGY, BACTERIOLOGY, BOTANY, GEOGRAPHY, GEOLOGY, MINERALOGY AND ZOOLOGY.		
1903. Cape Town ..	R. Marloth, M.A., Ph.D.	Prof. A. Dendy.
1904. Johannesburg	G. S. Corstorphine, B.Sc., Ph.D., F.G.S.	Dr. W. C. C. Pakes, W. H. Jollyman.
1906. Kimberley ..	Thos. Quentrall, M.I.Mech.E., F.G.S.	C. E. Addams, H. Simpson.
CHEMISTRY, METALLURGY, MINERALOGY, ENGINEERING, MINING AND ARCHITECTURE.		
1907. Natal	C. W. Methven, M.I.C.E., F.R.S.E., F.R.I.B.A.	R. G. Kirkby, W. Paton.
1908. Grahamstown	Prof. E. H. L. Schwarz, A.R.C.S., F.G.S.	Prof. G. E. Cory, R. W. Newman, J. Muller.

* Metallurgy added in 1904.

† Geography and Geodesy transferred to Section A and Chemistry and Metallurgy to Section B, in 1907.

‡ Irrigation added in 1910 and Geography transferred to Section B.

Date and Place.	Presidents.	Secretaries.
CHEMISTRY, BACTERIOLOGY, GEOLOGY, BOTANY, MINERALOGY, ZOOLOGY, AGRICULTURE, FORESTRY, SANITARY SCIENCE.		
1909. Bloemfontein	C. F. Juritz, M.A., D.Sc., F.I.C.	Dr. G. Potts, A. Stead.
CHEMISTRY, GEOLOGY, METALLURGY, MINERALOGY AND GEOGRAPHY.		
1910. Cape Town ..	A. W. Rogers, M.A., Sc.D., F.G.S.	J. G. Rose, G. F. Ayers.
1911. Bulawayo ..	A. J. C. Molyneux, F.G.S., F.R.G.S.	J. G. Rose, G. N. Blackshaw.
1912. Port Elizabeth	Prof. B. de St. J. van der Riet, M.A., Ph.D.	J. G. Rose, J. E. Devlin.
1913. Lourenço Marques	Prof. R. B. Young, M.A., D.Sc., F.R.S.E., F.G.S.	Prof. G. H. Stanley, Capt. A. Graça.
1914. Kimberley ..	Prof. G. H. Stanley, A.R.S.M., M.I.M.E., M.I.M.M., F.I.C.	J. G. Rose, J. Parry.
1915. Pretoria ..	H. Kynaston, M.A., F.G.S.	Dr. H. C. J. Tietz, Prof. D. F. du Toit Malherbe.
1916. Maritzburg. ..	Prof. J. A. Wilkinson, M.A. F.C.S.	Dr. H. C. J. Tietz, Prof. J. W. Bews.
1917. Stellenbosch ..	Prof. M. M. Rindl, Ing.D.	Dr. H. C. J. Tietz, Prof. B. de St. J. van der Riet.
SECTION C.—AGRICULTURE, ARCHITECTURE, ENGINEERING, GEODESY, SURVEYING, AND SANITARY SCIENCE.		
1903. Cape Town ..	Sir Chas. Metcalfe, Bart., M.I.C.E.	A. H. Reid.
1904. Johannesburg *	Lieut.-Colonel Sir Percy Girouard, K.C.M.G., D.S.O.	G. S. Burt Andrews, E. J. Laschinger.
1906. Kimberley ..	S. J. Jennings, C.E., M.Amer.I.M.E., M.I.M.E.	D. W. Greatbatch, W. Newdigate.
BACTERIOLOGY, BOTANY, ZOOLOGY, AGRICULTURE AND FORESTRY, PHYSIOLOGY, HYGIENE.		
1907. Natal	Lieut.-Colonel H. Watkins Pitchford, F.R.C.V.S.	W. A. Squire, A. M. Neilson, Dr. J. E. Duerden.
1908. Grahamstown	Prof. S. Schonland, M.A., Ph.D., F.L.S., C.M.Z.S.	Dr. J. Bruce Bays, W. Robertson, C. W. Mally, Dr. L. H. Gough.
1910. Cape Town †	Prof. H. H. W. Pearson, M.A., Sc.D., F.L.S.	W. D. Severn, Dr. J. W. B. Gunning.
1911. Bulawayo ..	F. Eyles, F.L.S., M.L.C.	W. T. Saxton, H. G. Mundy.
1912. Port Elizabeth	F. W. FitzSimons, F.Z.S., F.R.M.S.	W. T. Saxton, I. L. Drège.
1913. Lourenço Marques	A. L. M. Bonn, C.E.	F. Flowers, Lieut. J. B. Botelho.
1914. Kimberley ..	Prof. G. Potts, M.Sc., Ph.D.	C. W. Mally, W. J. Calder.
1915. Pretoria ..	C. P. Lounsbury, B.Sc., F.E.S.	C. W. Mally, A. K. Haagner.
1916. Maritzburg. ..	I. B. Pole-Evans, M.A., B.Sc., F.L.S.	C. W. Mally, Prof. E. Warren.
1917. Stellenbosch ..	J. Burtt-Davy, F.L.S., F.R.G.S.	C. W. Mally, C. S. Grobbelaar.

* Forestry added in 1904.
† Sanitary Science added in 1910.

Date and Place.	Presidents.	Secretaries.

SECTION D.—ARCHAEOLOGY, EDUCATION, MENTAL SCIENCE, PHILOLOGY, POLITICAL ECONOMY, SOCIOLOGY AND STATISTICS.

1903. Cape Town ..	Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E.	Prof. H. E. S. Fremantle.
1904. Johannesburg	(Sir Percy Fitzpatrick, M.L.A.), E. B. Sargant, M.A. (Acting).	Howard Pim, J. Robinson.
1906. Kimberley ..	A. H. Watkins, M.D., M.R.C.S.	E. C. Lardner-Burke, E. W. Mowbray.

ANTHROPOLOGY, ARCHÆOLOGY, ECONOMICS, EDUCATION ETHNOLOGY. HISTORY, PSYCHOLOGY, PHILOLOGY, SOCIOLOGY, AND STATISTICS.

1907. Natal	R. D. Clark, M.A.	R. A. Gowthorpe, A. S. Langley, E. A. Belcher.

ARCHÆOLOGY, EDUCATION, HISTORY, PSYCHOLOGY, AND PHILOLOGY.

1908. Grahamstown	E. G. Gane, M.A.	Prof. W. A. Macfadyen, W. D. Neilson.

ANTHROPOLOGY, ETHNOLOGY, EDUCATION, HISTORY, MENTAL SCIENCE, PHILOLOGY, POLITICAL ECONOMY, SOCIOLOGY AND STATISTICS.

1909. Bloemfontein	Hugh Gunn, M.A.	G. C. Grant, Rev. W. A. Norton.
1910. Cape Town ..	Rev. W. Flint, D.D.	G. B. Kipps, W. E. C. Clarke.
1911. Bulawayo ..	G. Duthie, M.A., F.R.S.E.	G. B. Kipps, W. J. Shepherd.
1912. Port Elizabeth	W. A. Way, M.A.	G. B. Kipps, E. G. Bryant.
1913. Lourenço Marques	J. A. Foote, F.G.S.	H. Pim, J. Elvas.
1914. Kimberley ..	Prof. W. Ritchie, M.A.	Prof. R. D. Nauta, A. H. J. Bourne.
1915. Pretoria ..	J. E. Adamson, M.A.	Prof. R. D. Nauta, R. G. L. Austin.
1916. Maritzburg ..	M. S. Evans, C.M.G., F.Z.S.	Prof. R. D. Nauta, Prof. O. Waterhouse.

EDUCATION, HISTORY, MENTAL SCIENCE, POLITICAL ECONOMY, GENERAL SOCIOLOGY, AND STATISTICS.

1917. Stellenbosch ..	Rev. B. P. J. Marchand, B.A.	Prof. R. D. Nauta, Dr. Bertha Stoneman.

SECTION E.—ANTHROPOLOGY, ETHNOLOGY, ECONOMICS, SOCIOLOGY, AND STATISTICS.

1908. Grahamstown	W. Hammond Tooke.	Prof. A. S. Kidd.

ANTHROPOLOGY, ETHNOLOGY, NATIVE EDUCATION, PHILOLOGY, AND NATIVE SOCIOLOGY.

1917. Stellenbosch ..	Rev. N. Roberts.	Rev. E. W. H. Musselwhite and Prof. J. J. Smith.

EVENING DISCOURSES.

Date and Place.	Lecturer.	Subject of Discourse.
1903. Cape Town ..	Prof. W. S. Logeman, B.A., L.H.C.	The Ruins of Persepolis and how the Inscriptions were read.
1904. Johannesburg	H. S. Hele-Shaw, LL.D., F.R.S., M.I.C.E.	Road Locomotion — Present and Future.
1906. Kimberley ..	Prof. R. A. Lehfeldt, B.A., D.Sc.	The Electrical Aspect of Chemistry.
	W. C. C. Pakes, L.R.C.P., M.R.C.S., D.P.H., F.I.C.	The Immunisation against Disease of Micro-organic Origin.
1907. Maritzburg ..	R. T. A. Innes, F.R.A.S., F.R.S.E.	Some Recent Problems in Astronomy.
Durban	Prof. R. B. Young, M.A., B.Sc., F.R.S.E., F.G.S.	The Heroic Age of South African Geology.
1908. Grahamstown	Prof. G. E. Cory, M.A.	The History of the Eastern Province.
	A Theiler, C.M.G.	Tropical and Sub-tropical Diseases of South Africa: their Causes and Propagation.
1909. Bloemfontein	C. F. Juritz, M.A., D.Sc., F.I.C.	Celestial Chemistry.
	W. Cullen.	Explosives: their Manufacture and Use.
Maseru	R. T. A. Innes, F.R.A.S., F.R.S.E.	Astronomy.
1910. Cape Town ..	Prof. H. Bohle, M.I.E.E.	The Conquest of the Air.
1911. Bulawayo ..	J. Brown, M.D., C.M., F.R.C.S., L.R.C.S.E.	Electoral Reform — Proportional Representation.
	W. H. Logeman, M.A.	The Gyroscope.
1912. Port Elizabeth	A. W. Roberts, D.Sc., F.R.A.S., F.R.S.E.	Imperial Astronomy.
	Prof. E. J. Goddard, B.A., D.Sc.	Antarctica.
1913. Lourenço Marques	S. Seruya.	The history of Portuguese conquest and discovery.
1914. Kimberley ..	Prof. E. H. L. Schwarz, A.R.C.S., F.G.S.	The Kimberley Mines, their discovery, and their relation to other volcanic vents in South Africa.
1915. Pretoria ..	E. T. Mellor, D.Sc., F.G.S., M.I.M.M.	The gold bearing conglomerates of the Witwatersrand.
	C. W. Mally, M.Sc., F.E.S., F.L.S.	The House fly under South African conditions.
1916. Maritzburg ..	C. P. Lounsbury, B.Sc., F.E.S.	Scale Insects and their travels.
Durban. ..	R. T. A. Innes, F.R.A.S., F.R.S.E.	Astronomy.
1917. Stellenbosch ..	H. E. Wood, M.Sc., F.R.Met.S.	Some unsolved problems of Astronomy
	Prof. J. D. F. Gilchrist, M.A., D.Sc., Ph.D., F.L.S., C.M.Z.S.	Some marine animals of South Africa.

GENERAL MEETINGS AT STELLENBOSCH.

On *Monday, July* 2, at 2.30 p.m., the Association was officially welcomed by His Worship the Mayor of Stellenbosch (Councillor P. D. Cluver) in the Assembly Hall of the Education Building, Victoria College.

At 8.15 p.m., in the Conservatorium Hall, Prof. J. Orr, B.Sc., M.I.C.E., M.I.Mech.E., took the chair as President, and delivered an address, for which see page 1.

The President subsequently presented the South Africa Medal to Prof. J. D. F. Gilchrist, M.A., D.Sc., Ph.D., F.L.S., C.M.Z.S. For the proceedings, see page xxxvi.

On *Tuesday, July* 3, at 3 p.m., Members of the Association attended a reception held by His Worship the Mayor of Stellenbosch, in the Hall of the Main College Building, and subsequently proceeded on short local trips to the farm of Mr. E. Lange, Nooitgedacht, to Vlottenberg Distillery, to the Oude Molen Distillery, and to Winshaw's Grape Juice Works.

At 8.15 p.m., in the Conservatorium Hall, Mr. H. E. Wood, M.Sc., F.R.Met.S., delivered a discourse on "Some Unsolved Problems of Astronomy," the President of the Association presiding.

On *Wednesday, July* 4, at 8.15 p.m., Members of the Association attended a reception held by Prof. J. T. Morrison, M.A., B.Sc., F.R.S.E., and the members of the Reception Committee, in the Hall of the Main College Building.

At 3.30 p.m. Members proceeded on excursions to the Government Trout Hatchery, Jonker's Hoek, and to the Government School of Agriculture, Elsenburg.

On *Thursday, July* 5, at 10.30 a.m., the Fifteenth Annual General Meeting was held in the Assembly Hall of the Education Building, Victoria College, for Minutes of which see page xxiii.

At 8.15 p.m., in the Conservatorium Hall, Prof. J. D. F. Gilchrist, M.A., D.Sc., Ph.D., F.L.S., C.M.Z.S., delivered a discourse on "Some Marine Animals of South Africa," the President of the Association presiding.

On *Friday, July* 6, at 9.15 a.m., and at 2 p.m., Members proceeded on a visit to Lourensford, the estate of Mr. J. W. Jagger, F.S.S., M.L.A., and to the Cape Explosives Works at Somerset West.

On *Saturday, July* 7, at 10 a.m., Members proceeded on a visit to Schoongezicht, the estate of the Right Hon. J. X. Merriman, P.C., LL.D., M.L.A.

OFFICERS OF LOCAL AND SECTIONAL COMMITTEES, STELLENBOSCH, 1917

LOCAL COMMITTEE.

Chairman, Prof. J. T. Morrison, M.A., B.Sc., F.R.S.E., Rev. Prof. N. J. Brümmer, M.A., B.D., Miss A. V. Duthie, M.A., Prof. E. J. Goddard, D.Sc., A. I. Perold, B.A., Ph.D., L. Simons, B.Sc., Miss B. Stoneman, D.Sc. *Local Secretary,* Prof. B. de St. J. van der Riet, M.A., Ph.D.

RECEPTION COMMITTEE.

Chairman, His Worship the Mayor of Stellenbosch (Councillor P. D. Cluver); the Deputy Mayor (Councillor C. M. Neethling); Councillors J. H. Classens, T. J. de Waal, C. F. Hunt, J. J. C. Heynecke, J. D. Krige, C. G. Marais and J. Rattray; Right Hon. J. X. Merriman, P.C., LL.D., M.L.A., Hon. Sir Thos. W. Smartt, K.C.M.G., L.R.C.S.I., L.K.Q.C.P.I., M.L.A., J. F .Joubert (C.C. and R.M.), Lord de Villiers, D. J. Ackerman (Registrar, Victoria College), W. E. Barker, K. Bairnsfather, H. Bairnsfather, D. Beyers, J. L. Beyers, A. M. Bosman, D. J. Bosman, Rev. D. S. Botha, M. J. Burnard, G. Chapman, A. H. Cluver, LL.B., F. A. Cluver, Ph.D., LL.B., C. M. Cunningham, A. B. de Villiers, A. F. de Villiers, W. B. de Villiers, Wilhelm de Villiers, J. H. de Wet, J. P. de Wet, W. E. Dümmer (Mayor of Somerset West), P. A. B. Faure, W. Gilchrist, G. J. Gird, Rev. G. Golightly, J. Gutsche, Ph.D., E. Hamlin, B.Sc., J. W. Jagger, F.S S., M.L.A., Prof. F. W. Jannasch, W. John, G. J. Krige, W. A. Krige, E. Lange, J. P. Louw, M. L. Louw, Dr. J. W. C. Macpherson, P. R. Malleson, Rev. Prof. J. I. Marais, D.D., Rev. W. N. C. Marchant, A. F. Markotter, B.A., A. H. Marnham, Rev. Prof. A. Moorrees, Jan H. Morkel, Dr. J. H. Neethling, I. M. Nel, Rev. Father E. O'Reilly, B. Perl, H. E. V. Pickstone, J. Rawbone, J. P. Roux, J. W. H. Roux, P. J. Roux, R. Santhagens, J. E. Scholtz, I. Tribolet, Prof. P. van Braam, E. B. van der Riet, J. G. van Helsdingen, Dr. I. J. Versfeld, Rev. J. Weber, J. H. Wicht, W. C. Winshaw. *Hon. Secretary*: H. J. Louw.

SECTIONAL COMMITTEES.

SECTION A.—ASTRONOMY, MATHEMATICS, PHYSICS, METEOROLOGY, GEODESY, SURVEYING, ENGINEERING, ARCHITECTURE, AND IRRIGATION.

President, Prof. W. N. Roseveare, M.A.; *Vice-Presidents,* S. S. Hough, M.A., F.R.S., and A. H. Reid, F.R.I.B.A., F.R.San.I.; *Members,* P. Cazalet, Prof. L. Crawford, M.A., D.Sc., F.R.S.E., C. J. Gyde, A.M.I.C.E., W. Ingham, M.I.C.E., M.I.M.E., R. T. A. Innes, F.R.A.S., F.R.S.E., F. E. Kanthack, C.M.G., M.I.C.E.,

M.I.M.E., J. Lunt, D.Sc., F.I.C., R. W. Menmuir, A.M.I.C.E., Prof. J. T. Morrison, M.A., B.Sc., F.R.S.E.,, Prof. A. Ogg, M.A., B.Sc., Ph.D., and Prof. J. Orr, B.Sc., M.I.C.E., M.I.Mech.E.; *Hon. Secretaries,* Prof. A. Brown, M.A., B.Sc., F.R.S.E. (*Recorder*), and L. Simons, B.Sc.

Section B.—CHEMISTRY, GEOLOGY, METALLURGY, MINERALOGY AND GEOGRAPHY.

President, Prof. M. M. Rindl, Ing.D.; *Vice-Presidents,* H. H. Green, D.Sc., F.C.S., and P. A. Wagner, Ing.D., B.Sc.; *Members,* W. A. Caldecott, B.A., D.Sc., F.C.S., F. Flowers, F.R.G.S., F.R.A.S., C. F. Juritz, M.A,, D.Sc., F.I.C., W. F. Grant, B.Sc., J. Hutcheon, M.A., F.R.S.G.S., Prof. D. F.du T. Malherbe, M.A., Ph.D., Prof. E. H. L. Schwarz, A.R.C.S., F.G.S., Prof. G. H. Stanley, A.R.S.M., M.I.M.E., M.I.M.M., F.I.C., Prof. J. A. Wilkinson, M.A., F.C.S., C. Williams, B.Sc., A.R.C.S., Prof. R. B. Young, M.A., D.Sc., F.R.S.E., F.G.S.; *Hon. Secretaries,* H. C. J. Tietz, M.A., Ph.D. (*Recorder*), and Prof. B. de St. J. van der Riet, M.A., Ph.D.

Section C.—BACTERIOLOGY, BOTANY, ZOOLOGY, AGRICULTURE, FORESTRY, PHYSIOLOGY, HYGIENE, AND SANITARY SCIENCE.

President, J. Burtt-Davy, F.L.S., F.R.G.S.; *Vice-Presidents,* Prof. E. J. Goddard, B.A., D.Sc., and A. Holm; *Members,* Dr. A. J. Anderson, M.A., M.B., D.P.H., M.R.C.S., Prof. J. W. Bews, M.A., D.Sc., H. Fielden Briggs, M.D., L.D.S., F.C.S., H. Cooke, B.S.A., I. B. Pole Evans, M.A., B.Sc., F.L.S., F. W. FitzSimons, F.Z.S., F.R.M.S., Prof. J. D. F. Gilchrist, M.A., D.Sc., Ph.D., F.L.S., J. S. Henkel, Lt.-Col. J. Hyslop, D.S.O., M.B., C.M., D. Kehoe, M.R.C.V.S., C. E. Legat, J. Leighton, F.R.H.S., C. P. Lounsbury, B.Sc., F.E.S., A. I. Perold, B.A., Ph.D., E. P. Phillips, M.A., D.Sc., F.L.S., Prof. G. Potts, M.Sc., Ph.D., E. Holmes Smith, B.Sc., A. Stead, B.Sc., F.C.S., Miss B. Stoneman, D.Sc., P. A. van der Byl,, M.A., D.Sc., F.L.S., Prof. H. A. Wager, A.R.C.S., Prof. E. Warren, D.Sc.; *Hon. Secretaries,* C. W. Mally, M.Sc., F.L.S., F.E.S. (*Recorder*), and C. S Grobbelaar, M.A.

Section D.—EDUCATION, HISTORY, MENTAL SCIENCE, POLITICAL ECONOMY, GENERAL SOCIOLOGY, AND STATISTICS.

President, Rev. B. P. J. Marchand, B.A.; *Vice-Presidents,* Prof. T. M. Forsyth, M.A., D.Phil., and Prof. R. Leslie, M.A., F.S.S.; *Members,* R. A. Buntine, M.L.A., M.B., B.Ch., Rev. W. Flint, D.D., J. A. Foote, F.G.S., F.E.I.S., Prof. W. A. Macfadyen, M.A., LL.D., Rev. A. M. McGregor, M.A., B.D., Prof. W. M. Macmillan, B.A., Rev. Prof. N. J. Brummer,

M.A., B.D., B. M. Narbeth, B.Sc., F.C.S.; *Hon. Secretaries*, Prof. R. D. Nauta (*Recorder*), and Miss Bertha Stoneman, D.Sc.

SECTION E.—ANTHROPOLOGY, ETHNOLOGY, NATIVE EDUCATION, PHILOLOGY, AND NATIVE SOCIOLOGY.

President, Rev. N. Roberts; *Vice-Presidents*, Rev. J. R. L. Kingon, M.A., F.L.S., and Rev. W. A. Norton, B.A., B.Litt.; *Members*, S. G. Campbell, M.D., M.Ch., F.R.C.S.E., M.R.C.S., D.P.H., Rev. S. S. Dornan, M.A., F.G.S., M. S. Evans, C.M.G., F.Z.S., S. Evans, W. Hay, J.P., C. T. Loram, M.A., LL.B., Ph.D., L. A. Péringuey, D.Sc., F.E.S., F.Z.S., Rev. C. Pettman, A. W. Roberts, D.Sc., F.R.A.S., F.R.S.E., S. Seruya, Miss M. Wilman; *Hon Secretaries*, Revs. E. W. H. Musselwhite, B.A. (*Recorder*), and Prof. J. J. Smith, B.A., LL.B.

PROCEEDINGS OF THE FIFTEENTH ANNUAL GENERAL MEETING OF MEMBERS.

(*Held in the Education Building, Victoria College, Stellenbosch, on Thursday, July* 5, 1917.)

Present: Prof. J. Orr, B.Sc., M.I.C.E., M.I.Mech.E. (President), in the chair; Prof. J. W. Bews, Prof. A. Brown, J. Burtt-Davy, F. W. P. Cluver, Prof. L. Crawford, Miss A. V. Duthie, D. F. du Toit, P. J. du Toit, Prof. H. B. Fantham, Rev. J. FitzHenry, Rev. Dr. W. Flint, Prof. T. M. Forsyth, S. Garside, Prof. E. J. Goddard, Dr. H. H. Green, C. S. Grobbelaar, L. D. Jones, Rev. Dr. F. C. Kolbe, Dr. J. R. Leech, J. Leighton, Prof. R. Leslie, Dr. J. Lunt, Prof. W. A. Macfadyen, Mrs. H. M. McKay, J. McLaren, P. R. Malleson, Mrs. B. M. Malleson, C. W. Mally, Rev. B. P. J. Marchand, Prof. R. Marloth, J. Mitchell, Prof. J. T. Morrison, Prof. C. E. Moss, Rev. E. W. H. Musselwhite, J. H. Neethling, Mrs. J. Orr, Dr. A. I. Perold, A. H. Reid, S. G. Rich, Prof. M. M. Rindl, Dr. A. W. Roberts, Rev. N. Roberts, J. W. A. Rose, Prof. W. N. Roseveare, Prof. S. J. Shand, L. Simons, Hon. Sir T. W. Smartt, Prof. J. J. Smith, Dr. Bertha Stoneman, Miss A. Townsend, J. S. van der Lingen, Prof. C. D. van der Merwe, Dr. H. G. Viljoen, Rev. Dr. S. R. Welch, and Miss M. Wilman; J. A. Foote and Dr. C. F. Juritz (General Secretaries), and H. Tucker (Assistant General Secretary).

Minutes.—The Minutes of the Fourteenth Annual General Meeting, held at Pietermaritzburg on 6th July, 1916, and printed on pp. xxi to xxvi of the Report of the Pietermaritzburg Session, were confirmed.

Annual Report of Council.—The Annual Report of the Council for 1916-17 having been suspended in the Vestibule since 4th July, was taken as read, and adopted on the motion of Prof. Rindl (see p. xxviii).

Report of General Treasurer and Statement of Accounts for 1916-17.—The General Treasurer's Report and the audited Financial Statements for the year ended 31st May, 1917, having been suspended in the Vestibule since 3rd July, were taken as read, and adopted on the motion of Prof. Rindl (see p. xxxiii).

Election of Officers for 1917-18.—The following Officers were elected for 1917-18:—

President, Dr. C. F. Juritz, M.A., F.I.C.; Vice-Presidents, Mr. W. Ingham, M.I.C.E., M.I.M.E., Mr. A. H. Reid, F.R.I.B.A., F.R.San.I., Prof. W. N. Roseveare, M.A., and Mr. H. E. Wood, M.Sc., F.R.Met.S.; General Secretaries, Rev. W. Flint, D.D., and Mr. J. A. Foote, F.G.S., F.E.I.S.; General Treasurer, Mr. A. Walsh.

Election of Council Members for 1917-18.—The following were elected Members of Council for 1917-18 (the Retiring President, Prof. J. Orr, B.Sc., M.I.C.E., M.I.Mech.E., being also *ex officio* a Member of Council for the year):—

I. Cape Province.—(1) *Cape Peninsula*: Prof. A. Brown, M.A., B.Sc., Prof. L. Crawford, M.A., D.Sc., F.R.S.E., Prof. R. Leslie, M.A., F.S.S., Mr. C. W. Mally, M.Sc., F.E.S., F.L.S., and Mr. R. W. Menmuir, A.M.I.C.E. (2) *Kimberley*: Miss M. Wilman. (3) *King William's Town*: Mr. J. Leighton, F.R.H.S. (4) *Middelburg*: Mr. A. Stead, B.Sc., F.C.S. (5) *Port Elizabeth*: Rev. J. R. L. Kingon, M.A., F.L.S. (6) *Stellenbosch*: Prof. J. T. Morrison, M.A., B.Sc., F.R.S.E., and Prof. B. de St. J. van der Riet, M.A., Ph.D.

II. Transvaal.—(1) *Witwatersrand*: Mr. J. Burtt-Davy, F.L.S., F.R.G.S., Dr. W. A. Caldecott, B.A., D.Sc., F.C.S., Mr. P. Cazalet, Lieut.-Col. J. H. Dobson, D.S.O., M.Sc., M.I.Mech.E., M.I.E.E., A.M.I.C.E., Prof. H. B. Fantham, M.A., D.Sc., A.R.C.S., F.Z.S., Mr. R. T. A. Innes, F.R.A.S., F.R.S.E., Mr. J. W. Kirkland, M.Am.I.E.E., Prof. C. E. Moss, M.A., D.Sc., F.L.S., F.R.G.S., Dr. A. J. Orenstein, Prof. G. H. Stanley, A.R.S.M., M.I.M.E, M.I.M.M., F.I.C., Mr. H. A. Trubshaw and Prof. J. A. Wilkinson, M.A., F.C.S. (2) *Pretoria*: Mr. I. B. Pole Evans, M.A., B.Sc., F.L.S., Prof. W. A. Macfadyen, M.A., LL.D., Prof. D. F. du Toit Malherbe, M.A., Ph.D., and Prof. H. A. Wager, A.R.C.S. (3) *Potchefstroom*: Mr. E. Holmes Smith, B.Sc.

III. Orange Free State (including Basutoland).—Prof. T. F. Dreyer, B.A., Ph.D., and Prof. M. M. Rindl, Ing.D.

IV. Natal.—(1) *Durban*: Mr. M. S. Evans, C.M.G., F.Z.S., and Dr. C. T. Loram, M.A., LL.B. (2) *Pietermaritzburg*: Mr. J. S. Henkel and Prof. E. Warren, D.Sc.

V. Rhodesia.—*Bulawayo*: Rev. S. S. Dornan, M.A., F.G.S.

VI. Mozambique.—*Lourenço Marques*: Mr. S. Seruya.

Annual Session, 1918.—The President announced that an invitation to the Association to hold its next Annual Session at Johannesburg had been received from the Mayor of that city; and, on the motion of Rev. Dr. Flint, it was unanimously resolved to accept the invitation.

President for 1918-19, and Place of Meeting, 1919.—The President explained that informal proposals under the first head had been obtained, and would be dealt with by the incoming Council, which would also deal with an invitation from the Mayor of King William's Town for the Association to meet there in 1919. It was hoped that it might be possible to extend the Session to a visit to East London, so as to spend three days at each town.

Alterations to Constitution.—(1) *Intermission of Subscriptions*.—In the absence, through indisposition, of Mr. Innes, the following motion, of which he had given notice, was moved by Mr. H. E. Wood, and seconded by Rev. Dr. Welch:—

That the following Rule be incorporated in the Constitution, *viz.*: The Council shall have power to intermit the payment of the annual subscription in the case of members of at least six years' standing who, through misfortune, are unable to pay, and whose previous scientific work, in the Council's opinion, justifies such intermission.

The names of such "intermitted" members shall not be published, but supplied from time to time to the General Treasurer.

After discussion, an amendment was proposed by Prof. J. T. Morrison to the effect that, in lieu of amending the Constitution, the Council should be authorized at discretion, in individual cases in which such a course was shewn to be justified, to suspend the operation of the clause in Rule IV. (*b*) relating to payment of the annual subscription. The amendment was put to the vote and declared carried, and was then passed as a substantive motion.

(2) *Change of Headquarters.*—Mr. Burtt-Davy moved:—

That "Johannesburg" be substituted for "Capetown" in Rule VIII of the Constitution.

The motion was seconded by Mr. H. E. Wood, the main argument advanced being the preponderance in membership of the Witwtatersrand centre, which entitled it to 12 Council Members as against five members for the Cape Peninsula, and the unreasonableness of the position that the latter could overrule the views of the former.

After some discussion, during which it was pointed out that in any matter of importance brought forward by Witwatersrand or any other centre, the views of the entire Council, which consisted of 45 Members, would be obtained; and further, that the mover had given no details as to how it was proposed to meet the practical difficulties resulting from the change of the Headquarters, such as the performance of the Assistant Secretary's duties, the editing of the JOURNAL, and the removal of the Association's Library, the motion was put to the vote and declared lost, there being 11 votes in its favour and 37 against it.

AFFILIATION OF KINDRED SOCIETIES.—Prof. L. Crawford detailed the action taken by the Council during the past year in framing draft Rules in connection with the affiliation of Scientific and kindred Societies, and submitting these Rules for comment to the Natal Society for the Advancement of Science and Art, which was the only Society which at present sought affiliation. It was then moved by him, seconded by Prof. W. N. Roseveare, and carried without opposition, that the Association should adopt the following Rules, which should be printed with the Constitution as Bye-Laws:—

Philosophical and Scientific Societies, and other Associations of a kindred character may, on application to, and with the approval of the Council, affiliate with the S.A. Association for the Advancement of Science on the following conditions:—

1. That as a Society can only be affiliated on the approval of the Council, no minimum of Membership of such Society need be specified.
2. That each such Society shall pay the Association a minimum fee of £5 for a strength of 50 members or less, and a further £1 for each additional 10 or portion of 10 members.
3. That such Society shall be entitled to one copy of the SOUTH AFRICAN JOURNAL OF SCIENCE for each £1 paid to the Association.

4. That such Society may, if it has a strength of 50 members, be represented on the Council of the Association by its President or such other Member as may be nominated for the purpose.

5. That all members of affiliated Societies may join the Association as ordinary Members, with full privileges, at a reduced Annual Subscription of 15s.

6. That affiliated Societies shall be asked to take into consideration the admission of Members of the Association into their Societies at a reduced subscription.

7. That papers contributed to affiliated Societies may, on recommendation of both their own Council and that of the Association, be printed in the Association's JOURNAL OF SCIENCE, after which the authors shall be entitled to reprints on the usual terms.

SOUTH AFRICAN FOSSILS—REMOVAL FROM COUNTRY.—Prof. E. J. Goddard, after representing that a wholesale exportation of fossil types to America and elsewhere was taking place, moved the following resolution, which had been adopted by Section C. The motion was seconded by Prof. Fantham, and carried unanimously:—

That this Association views with alarm the exportation of such fossils and ethnological specimens as are types, or of such a kind as should be retained in this country; and requests the Government to take some steps towards regulating such exportation.

FEDERAL COUNCIL OF TECHNICAL SOCIETIES.—On the recommendation of the President, it was resolved to instruct the incoming Council to consider the question of initiating a Federal Council of Technical Societies

MEMORIAL TO SIR DAVID GILL.—The President explained that a proposal to take steps to provide some memorial to Sir David Gill, in view of his eminence as an astronomer, his long residence in South Africa, and his close connection with the Association—of which he was the first President—had been made by the Members of Council for the Witwatersrand centre in 1916; but the Council had suggested that the time was inopportune. He thought, however, that the matter should not be longer deferred, and proposed that it be a recommendation to the incoming Council to move in the matter. It was resolved to adopt the President's proposal.

FIFTIETH ANNIVERSARY OF THE DISCOVERY OF DIAMONDS.—The President having drawn attention to the fact that the present year was the fiftieth since the first discovery of diamonds in South Africa, Mr. A. H. Reid gave a *résumé* of the main facts relating to the discovery of diamonds and the subsequent vast developments of diamond-mining, and shewed how enormously the diamond industry had benefitted South Africa and had led to the development of its railways and its general prosperity; and he moved that the Association in Session should convey its congratulations to the Mayor of Kimberley on the fiftieth anniversary of so auspicious an event. The motion was carried unanimously.

LOYAL ADDRESS TO HIS MAJESTY THE KING.—On the motion of the President, it was resolved unanimously that the Governor-General be respectfully requested to transmit the following message to His Majesty the King:—

We, the members of the South African Association for the Advancement of Science, assembled at the fifteenth Annual Congress, at Stellenbosch, desire to convey to His Majesty the King the assurance of our heartfelt loyalty and unswerving devotion to His Majesty's person and Throne, and our confidence in a successful issue of the present struggle for liberty.

Assistant General Secretary—Bonus to.—The President referred appreciatively to the work done by the Assistant General Secretary, and moved that as present circumstances did not permit of an increase in the salary paid, a bonus of £10 10s. should be granted to him. This motion was carried unanimously.

Votes of Thanks.—On the motion of Mr. J. A. Foote, it was unanimously resolved that the hearty thanks of the Association should be accorded to the following:—

(1) To His Worship the Mayor and the Councillors of Stellenbosch, for the cordial welcome extended to the Association, and for the Reception given to the Members at the Main College Building.

(2) To the Local and Reception Committees, and especially to Professors Morrison and Van der Riet and Mr. Simons, for the excellent arrangements made for the accommodation, comfort and enjoyment of the visitors during the Session, and for the most agreeable Reception given to the Members in the Main College Building.

(3) To the Council of the Victoria College for their kindness in placing the College Buildings at the disposal of the Association as the Headquarters of the Session.

(4) To the Lady Principal and Committee of "Harmonie," for providing accommodation for Members at that institution, and for her unremitting efforts to secure their comfort.

(5) To the Ladies of Stellenbosch for their kind hospitality in connection with the provision of morning tea.

(6) To those gentlemen who so kindly provided motor cars for excursions.

(7) To the following gentlemen for receiving the Association during excursions to places of interest, and for hospitality extended to the members on these occasions: The Right Hon. J. X. Merriman, M.L.A., at Schoongezicht; Mr. J. W. Jagger, M.L.A., at Lourensford; Mr. W. C. Winshaw, Grape Juice Works; Mr. R. Santhagens, Distillery, Stellenbosch; Mr. E. Lange, Nooitgedacht; the Manager of the Jonkers Hoek Trout Hatchery; the Manager of the Lion Distillery; the Acting Manager of the Cape Explosives Works; and the Acting Principal of the Government School of Agriculture, Elsenburg.

(8) To the local Golf Club, for extending the privileges of Honorary Membership to Members during the Session, and to the Tennis Clubs for placing their courts at Members' disposal.

(9) To the daily Press for its appreciative references to the proceedings of the Session.

REPORT OF THE COUNCIL FOR THE YEAR ENDED 30TH JUNE, 1917.

1. Obituary: Your Council desires to place on record its sense of the great loss which this Association and the entire Union has sustained in the untimely decease of Prof. H. H. W. Pearson, M.A., Sc.D., F.R.S., F.R.S.S.Af., a former Member of Council and Past-President of Section C. Your Council also regrets the death of Mr. M. White, M.A., on active service in German East Africa, and of Sir William Thorne, Kt., Senator the Hon. Sir Marshall Campbell, and Messrs. J. W. Quinn, J.P., M.L.A., A. W. Wilson, and W. J. Davenport.

2. Membership: The war conditions, on which comments were made in the last two Annual Reports, are unfortunately still maintained, but there has, nevertheless, been a gratifying increase in the membership of the Association, which now numbers 128 more than a year ago. During the intervening twelve months no less than 181 new members have been enrolled. On the other hand the seven whose names have just been mentioned have died, and 46 have either resigned or were removed from the Members' Roll because of departure and unknown address, or because their subscriptions have remained outstanding for a number of years. In the list published on July 1st, only those new members' names appear who have already paid their first year's subscription.

The following is a comparative table, showing the number of Members on the roll on the two dates:—

	1916.	1917.
Cape Province	202	203
Transvaal	236	337
Orange Free State	36	37
Natal	51	83
Rhodesia	20	18
Basutoland	1	—
Mozambique	17	13
Swaziland	1	1
South-West Africa Protectorate	2	2
Abroad	17	17
Unknown	1	1
	584	712

At present the number of Life Members is 81; two have died during the year, and 11 new Life Members have been added.

3. Report of the Pretoria Meeting, 1915: The twelfth Annual Volume of the Transactions of the Association, comprising the proceedings at the Pretoria Session in 1915, has been completed in thirteen issues. The volume has now been bound in uniformity with those which preceded it, and consists in all of

806 pages; in other words, it is the largest Annual Volume which has yet been published by the Association, notwithstanding the fact that no less than 19 of the papers submitted at the Pretoria Session were printed in it by title only. Three papers were printed in brief abstract, one virtually in full, and 65 *in extenso*.

4. Report of the Maritzburg Meeting, 1916: The war conditions already referred to have delayed publication of the current Volume to the same extent as in the case of its immediate predecessor; the monthly issues are in consequence some three months in arrear.

5. Costs of Publications: The unusually large number of papers submitted at the Pretoria Session in 1915 and at the Maritzburg Session in 1916 caused a considerable increase in the bulk of the Association's volumes containing the Transactions at these Sessions. This fact, coupled with the need for printing a larger issue to meet the large increase in the Association's membership roll, and the increased cost of printing consequent upon war conditions, would have seriously straitened the Association in respect of its finances had it not been for the generosity of a number of Johannesburg mining houses and Capetown firms, which contributed a total of £195 1s. towards the Association's publication expenses. A further amount of £50 has been contributed by the Witwatersrand Council of Education.

6. South Africa Medal and Grant, 1917: The South Africa Medal Committee, comprising Prof. L. Crawford (Chairman), Mr. J. Burtt-Davy, Prof. J. E. Duerden, Mr. R. T. A. Innes, Dr. C. F. Juritz, Prof. R. A. Lehfeldt, Sir Thomas Muir, Kt., Prof. J. Orr, Prof. E. H. L. Schwarz, Sir Arnold Theiler, K.C.M.G., Prof. E. Warren, and Miss Wilman, recommended Prof. J. D. F. Gilchrist, M.A., D.Sc., Ph.D., F.L.S., F.R.S.S.Af., C.M.Z.S., Professor of Zoology at the South African College, Capetown, for the tenth award of the South Africa Medal, together with the Grant of £50, which has invariably been presented along with the Medal. This recommendation has been confirmed by Council.

7. Goold-Adams Medals, 1917.—The seventh series of awards of the Goold-Adams Medals was made in connection with the Matriculation and Senior Certificate Examinations of the University of the Cape of Good Hope held last December. The names of the recipients are as follows:—

Mathematics: Geoffrey William Smart, St. John's College, Johannesburg.

Physics: Edward Victor Kidger Tucker, South African College High School, Capetown; Johannes du Plessis Scholtz, Public School, Somerset West.

Chemistry: Llewellyn Spracklen, South African College High School, Capetown.

Physical Science: Johann Christian Vogel, High School, Durban.

Botany: Mildred Balmforth, Good Hope Seminary, Capetown.

8. Research Grant Committee: Your Council has appointed the Rev. Dr. Flint, Dr. C. F. Juritz, Mr. A. H. Reid, and Prof. A. Brown as its representatives on the 1917 General Committee for Research Grants administered by the Council of the Royal Society of South Africa; and a grant of £50 was awarded by this Committee to Mr. J. S. van der Lingen, B.A., for research in Radiology.

9. Industrial Research Committee: On the initiative of the South African Institution of Engineers, a Central Committee of Scientific and Technical Societies was constituted at Johannesburg for the purpose of furthering Industrial Research. In response to an invitation to nominate representatives on this Committee, your Council resolved to delegate Mr. J. Burtt-Davy, F.L.S., F.R.G.S., Mr. R. T. A. Innes, F.R.S.E., F.R.A.S., and Prof. John Orr, B.Sc., M.Inst.C.E., M.I.Mech.E., to represent it. The Department of Mines and Industries subsequently invited this Central Committee to nominate members of a Scientific and Technical Committee which the Government had decided to establish for the purpose of advising it on scientific and technical questions arising out of industrial development within the Union. Your Council supported the recommendation of the Central Committee to the effect that Professors J. C. Beattie, John Orr, R. B. Young, Dr. W. A. Caldecott, and Messrs. Burtt-Davy, L. Colquhoun and B. Price should be appointed as members of the Government Committee. This recommendation was adopted by the Government.

10. Memorial to the Late Rev. H. Berthoud: In commemoration of the labours of the late Rev. H. Berthoud, of the Swiss Mission, in the Zoutpansberg District of the Transvaal Province—which included the preparation of a valuable map of that region—it was proposed to give Mr. Berthoud's name to the mountain hitherto known at Madzibangombe's Hill. Your Council decided to communicate with the Surveyor-General of the Transvaal on the subject, and to express the hope that the proposal would be favourably entertained. This was done in due course, and your Council was informed that the mountain would henceforth be known as "Monbertou."

11. Metric System, Decimal Coinage, and "Daylight Saving.": At the Fourteenth Annual Meeting at Pietermaritzburg, resolutions dealing with these questions were passed at a combined meeting of Sections, and, after confirmation by the Council, were forwarded to the Government and other authorities. In order to press forward these reforms, on the initiative of the Council, a conference was held at Johannesburg on April 10, 1917, at which over 60 delegates were present, representing 34 Scientific and Technical Societies and Public Bodies in the Union of South Africa and Rhodesia. The following resolutions were passed:—

1. That the metric system of weights and measures be legalised at as early a date as possible, for permissive use until the end of the war, and that its use become compulsory and exclusive after such time as may be found practicable.

2. That the Government of the Union of South Africa should co-operate with the Home Government and those of the other self-governing Dominions with regard to the decimalisation of coinage.

3. That in view of the considerable advantages to be gained by a fuller use of daylight, the Government be requested to take into consideration the desirability of advancing the time of the Union one hour for six months of the year, from September 30 till March 31st.

4. That copies of these resolutions be sent to His Excellency the Governor-General, the Prime Minister, the Minister of Mines, and the Industries Advisory Board, the High Commissioner for South Africa (London), the British Colonial Secretary, the Decimal Association, London, and the South African Standards Committee.

5. That in order to make the metric system and its advantages more generally known in South Africa, the following steps be taken:—

(*a*) That popular lectures be given in the larger towns, explaining the system and enumerating its advantages; at which lectures local members of Parliament be asked to preside.

(*b*) That Municipalities be circularised and asked to purchase complete sets of commercial metric weights and measures.

(*c*) That a booklet, specially written for South African use, be prepared for free circulation or at a nominal figure.

Resolutions (1), (2) and (3) were subsequently referred by the delegates to their respective Societies and Public Bodies, with the result that resolutions (1) and (2) were unanimously confirmed, while there were only two dissentients to resolution No. (3). The resolutions have accordingly been sent to those mentioned in resolution No. (4).

12. Affiliation to British Association: Your Council applied to the British Association for the Advancement of Science last August for admission to the privileges of an "Affiliated Corresponding Society," in terms of Chapter XI., Section I., of the British Association's Constitution. Your Council has not yet received any reply.

13. Affiliation of Kindred Societies: In pursuance of the principle approved at the Annual General Meeting held in Maritzburg last year, your Council has considered the conditions under which other Scientific and Kindred Societies should be allowed to affiliate with this Association. The terms of affiliation have been drafted and submitted to the various Societies which had approached the Association with a view to affiliation.

14. Time of Year for Holding Annual Session: The advisability of altering the time of year at which the Annual Sessions of the Association are held was discussed at the last Annual General Meeting, and referred to the Council for consideration. Your Council has considered it desirable to continue holding the Annual Session during July as heretofore.

15. Printing of Papers Prior to Session: Your Council has also, in accordance with instructions from the last Annual General Meeting, considered the practicability of having the papers notified for reading at the Annual Sessions, or *résumés* of those papers, printed in advance, but has not adopted any resolution, as it was found difficult to arrive at any practical conclusion.

16. Conduct of Sectional Meetings: Consequent on the resolution of the last Annual General Meeting, your Council has drawn up a series of Bye-laws for the guidance of Sectional Officers in the conduct of business in relation to the Annual Session of the Association. These Bye-laws were communicated to all the Sectional Officers in time for operation in connection with the present Session, and have also been printed in the Circulars recently issued to all Members of the Association.

17. The New Council: On the basis of Membership provided for in the Constitution of the Association, Section VI. (*d*), the number of Members of Council assigned to the representation of each centre during the ensuing twelve months should be distributed as follows:—

Cape Province—	
Cape Peninsula	4
Port Elizabeth	1
Kimberley	1
King William's Town	1
Middelburg	1
Stellenbosch	2
Transvaal—	
Witwatersrand	12
Pretoria	4
Potchefstroom	1
Orange Free State (with Basutoland)—	
Bloemfontein	2
Natal—	
Maritzburg	2
Durban	2
Rhodesia—	
Bulawayo	1
Mozambique—	
Lourenço Marques	1
	35

REPORT OF THE HONORARY TREASURER FOR THE YEAR ENDED MAY 31ST, 1917.

In presenting the account of revenue and expenditure and the audited balance-sheets for the year ending May 31st, 1917, I beg to report as follows:—

The year that has just closed has been an excellent one, so far as the revenue of the Society is concerned, for, compared with 1916, there has been an increase of £135 15s., made up of interest, £29 3s. 4d., and subscriptions, £106 11s. 8d.

On the expenditure side the general expenses have amounted to £253 13s. 5d., as against £242 0s. 8d. in 1916; the difference being practically accounted for by the increase in grants under Rule 9 and the expenses of the Goold-Adams Medals.

But in the expenses in connection with the issue of the Journal the nett debit for the year is £363 10s. 3d., as against £224 18s. 11d. for the preceding year, an increase of £138 11s. 4d., and this, notwithstanding that there has been an increase of £91 in the special contribution towards the publication expenses.

The great delay in the publishing of the monthly numbers prevents any comparison with previous years, when the publication has been regular, but I would point out that the cost of the Journal as shown does not include the special July number or the ordinary numbers from February to May, inclusive.

The actual payments made on account of the Journal for the year under review has been £621 17s. 3d., as compared with payments for previous years:—

	£	s.	d.		£	s.	d.
1916	357	17	9	1915	478	17	8
1914	230	6	7	1913 (11 months)	259	5	4
1912	426	14	5	1911	256	19	11

The Endowment Fund has been increased by a sum of £90, being the amount of Life Members' Composition for the year.

The Medal Fund balance now stands at £1,440 17s. 3d.

With the balance-sheet I enclose the trustees' statement as to how the Endowment Fund and Medal Fund assets are invested.

A. WALSH,
Treasurer.

June 27th, 1917.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

REVENUE AND EXPENDITURE ACCOUNT FOR YEAR ENDED 31ST MAY, 1917.

Expenditure.

	£ s. d.	£ s. d.
To Assistant Secretary's Salary ...		120 0 0
,, Rent		30 0 0
,, Journal		363 10 3
,, Printing and Stationery.. ...		31 7 3
,, Stamps and Telegrams... ...		15 2 10
,, Sundry Charges—		
Caretaker	6 0 0	
Exchange	1 18 10	
Audit	5 5 0	
P.O. Box and Telegraphic Add.	2 1 0	
Photograph	0 4 0	
Expenses	0 7 2	
Goold-Adams Medals.. ...	4 7 10	
Cheque Book	0 10 0	
Grants under Rule 9	19 14 0	
Expenses of Annual Meeting ...	13 1 1	
		53 8 11
,, Depreciation on Furniture ...		3 14 5
,, Balance to Balance Sheet. ...		240 0 1
		£866 3 9

Revenue.

	£ s. d.	£ s. d.
By Balance carried forward from 1916		208 11 7
,, Subscriptions, 1916-1917.. ...	501 14 0	
,, Arrear Subscriptions	79 8 4	
		581 2 4
,, Interest on Endowment Fund ...		75 14 10
,, Associate Members	0 15 0	
		0 15 0
		£866 3 9

BALANCE SHEET AS AT 31ST MAY, 1917.

Liabilities.

	£ s. d.	£ s. d.
Capital Account		249 0 1
Medal Fund		1,440 17 3
Endowment Fund		1,498 0 0
Subscriptions paid in advance ...		11 0 0
		£3,198 17 4

Assets.

	£ s. d.	£ s. d.
Trustees of Medal Fund	1,440 17 3	
Trustees of Endowment Fund ...	1,498 0 0	
		2,938 17 3
Cash—		
Standard Bank of S. Africa, Ltd.	64 5 1	
Cape Good Hope Savings Bank ...	162 4 10	
		226 9 11
Furniture		33 10 2
		£3,198 17 4

SOUTH AFRICA MEDAL FUND.

Revenue and Expenditure Account *for the year ended 31st May*, 1917.

	£ s. d.		£ s. d.	£ s. d.
To Dr. Gilchrist, Grant for 1917	50 0 0	By Balance 31st May, 1916... ...	1,436 0 11	
,, Typing copies of nominations for circulation to Members of Medal Committee... ...	2 0 0	,, Interest	57 0 8	
				1,493 1 7
,, Engraving Medals	0 4 4			
,, Balance	1,440 17 3			
	£1,493 1 7			£1,493 1 7

ENDOWMENT FUND.

For Year ended 31st May, 1917.

	£ s. d.		£ s. d.
To Interest paid to General Account	69 0 0	By Balance	1,408 0 0
,, Balance	1,498 0 0	,, Interest	69 0 0
		,, Life Members' Subscriptions	90 0 0
	£1,567 0 0		£1,567 0 0

I hereby certify that I have examined the above Balance Sheet and Revenue Account with the books, vouchers, and Banker's Pass Book relating thereto, and that in my opinion they correctly set forth a true and correct statement of the affairs of the Association as shown by the books thereof.

p. pro HY. GIBSON,

J. B. Reynolds,

Incorporated Accountant,
Certified Accountant (Cape).

Capetown, 25th June, 1917.

TENTH AWARD OF THE SOUTH AFRICA MEDAL AND GRANT.

(*Fund raised by Members of the British Association in commemoration of their visit to South Africa in* 1905.)

After the conclusion of the Presidential Address in the Hall of the Conservatorium, on Monday, July 3, 1917, the President, Prof. J. Orr, handed the South Africa Medal and Grant of £50 to Prof. JOHN DOW FISHER GILCHRIST, M.A., D.Sc., Ph.D., F.L.S., C.M.Z.S. In making the presentation, the President said:—

Dr. Gilchrist studied Zoology at the Universities of Edinburgh, Munich and Zurich. Thereafter he specialized in Marine Zoology, and carried out original work at the Naples and other Marine Biological Stations. He was then for a time Assistant in the Zoological Department of the University of Edinburgh, after which he was, on the nomination of Sir John Murray and Prof. M'Intosh, F.R.S., appointed Marine Biologist to the Government of the Cape of Good Hope. On his recommendation, a Marine Biological Survey was undertaken by the Cape Government, and he was entrusted with the purchase and equipment of a steam vessel, which he specially designed for this purpose. The results of this work, carried out under his direction, have been of great scientific importance, and have been published in a series of Reports to the Government, and in "Marine Investigations in South Africa," as well as in other scientific publications. At the request of the Government of Natal, the survey was extended to Natal waters, in view of the results attained, and further valuable information was secured. The large collections made have not yet been fully reported on, but over 450 genera and species of marine animals new to science have now been described, besides many more new to the South African seas.

On Dr. Gilchrist's recommendation, a Marine Biological Laboratory was built at St. James, in False Bay, in connection with Marine Biological research, and further information with reference to the habits of South African marine animals has been obtained, particularly with regard to the eggs and early stages of South African fishes, a subject hitherto entirely uninvestigated.

The practical results of this scientific work have been of great importance to South Africa. Extensive new fishery areas, particularly on the Agulhas Bank, have been discovered, and these have been shewn to abound in fish, particularly soles, formerly a rarity in South Africa. The exploratory work has been followed up by private enterprise, including a new trawling industry, and now representing a capital of over £150,000.

In the year 1905 Dr. Gilchrist was appointed to the post of Professor of Zoology in the South African College, and has

continued his research, chiefly in Marine Zoology. He has, however, extended his work, and, with the aid of a grant from the British and South African Associations for the Advancement of Science, has made a collection of fresh-water fishes of South Africa. With this material, together with other specimens from various museums in South Africa, he has, in conjunction with the late Mr. W. Wardlaw Thompson, F.Z.S., now completed a fully illustrated monograph of the South African Fresh-Water Fishes, many new and unrecorded species being added.

Dr. Gilchrist is an M.A. and D.Sc. of the University of Edinburgh, Ph.D. of the University of Zurich, Corresponding Member of the Zoological Society, London, and Honorary Member of the Société Centrale d'Agriculture, Paris. He was President of the South African Philosophical Society, and took an active part in the formation of the South African Association for the Advancement of Science, of which he was the first Joint Honorary Secretary, as also Joint Honorary Secretary of the Organising Committee for the visit of the British Association to South Africa in 1905.

He is author of "South African Zoology: a Text Book for Zoological Students"; of "Reports of the Cape Government Biologist, 1895-1904"; editor and part author of the five volumes of "Marine Investigations in South Africa"; joint editor of "Science in South Africa"; translator of "Monism," by Prof. Ernest Haeckel; and author of numerous papers in scientific publications, of which the following is a list of the more important:—

Palleal Complex of *Dolabella*. (*Proc. Roy. Soc. Ed.*)
Torsion of the Molluscan Body. (*Proc. Roy. Soc. Ed.*)
Beitrage sur Kenntis der Anordung Correlation und Funktion der Mantelorgane der Tectibranchiata. (*Jenaische Zeitschrift.*)
On the Group of the Aplysiidæ, with Description of a New Species. (*Ann. and Mag. Nat. Hist.*)
Note on the Minute Structure of the Nervous System of the Mollusca. (*Journ. Linn. Soc.*)
The Genus Paraplysia, with description of a New Species. (*Trans. S. Afr. Phil. Soc.*)
New Forms of the Hemichordata from S. Africa. (*Trans. S. Afr. Phil. Soc.*)
Catalogue of Fishes recorded from S. Africa. (*Mar. Inv. in S. Africa*, **1.**)
Observations on the Temperature and Salinity of the Sea around the Cape Peninsula. (*Mar. Inv. in S. Afr.* **2.**)
South African Fishes. (*Mar. Inv. in S. Afr.* **2.**)
Currents on the South African Coast. (*Mar. Inv. in S. Africa.* **2.**)
The Development of South African Fishes. (*Mar. Inv. in S. Afr.* **2** and **3.**)
Description of New South African Fishes. (*Mar. Inv. in S. Afr.* **2.**)
Description of New South African Fishes. (*Mar. Inv. in S. Afr.* **3.**)
Description of Fifteen New South African Fishes, with Notes on other Species. (*Mar. Inv. in S. Afr.* **4.**)
New Forms of the Hemichordata from S. Africa (*Mar. Inv. in S. Afr.* **5.**)
On Two New Species of Ptychodera. (*Ann. S. Afr. Mus.* **6.**)
A Free-swimming Nauplioid Stage in *Palinurus*. (*Journ. Linn. Soc.*)

Observations on the Cape *Cephalodiscus* and some of its early stages. (*Ann. and Mag. Nat. Hist.* **16.**)
Review of the S. African Clupeidæ. (*Marine Biologists's Report.* **1.**)
Observations on the habits of some S. African Fishes. (*Marine Biologist's Report*, **2.**)
Descriptions of New South African Fishes. (*Marine Biologist's Report.* **2.**)

In course of publication—

Post-larval Stages of *Jasus Lalandii.* (*Journ. Linn. Soc.*)
The Development of the Cape *Cephalodiscus.* (*Quart. Journ. Mic. Soc.*)

Joint Papers with W. W. Thompson, F.ZS., F.L.S.—

Descriptions of Fishes from the Coast of Natal. Parts 1-4. (*Ann. S Afr. Mus.* **6-13.**)
Descriptions of Three New Species of Fresh-Water Fishes from South Africa. (*Ann. and Mag. Nat. Hist.*)
The Cape Klip-Fishes. (*Rept. S.A.A.A.Sc.*)
The Fresh-Water Fishes of South Africa. (*Ann. S. Afr. Mus.* **11.**)

Professor Gilchrist expressed his thanks in appropriate terms, referring with gratification to his connection with the Association during its early days.

Previous Recipients.

1908. *Grahamstown.*—Arnold Theiler, C.M.G., V.M.D., Bacteriologist to the Transvaal Government, Pretoria.
1909. *Bloemfontein.*—Harry Bolus, D.Sc., F.L.S., of Sherwood, Kenilworth, Cape Division.
1910. *Capetown.*—John Carruthers Beattie, D.Sc., F.R.S.E., Professor of Physics, South African College, Capetown.
1911. *Bulawayo.*—Louis Péringuey, D.Sc., F.E.S., F.Z.S., Director of the South African Museum, Capetown.
1912. *Port Elizabeth.*—Alexander William Roberts, D.Sc., F.R.A.S., F.R.S.E., of Lovedale Observatory, C.P.
1913. *Lourenço Marques.*—Arthur William Rogers, M.A., Sc.D., F.G.S., Assistant Director of the Union Geological Survey, Capetown.
1914. *Kimberley.*—Prof. Rudolph Marloth, M.A., Ph.D., Capetown.
1915. *Pretoria.*—Charles Pugsley Lounsbury, B.Sc., F.E.S., Chief of the Division of Entomology, Union Department of Agriculture, Pretoria.
1916. *Maritzburg.*—Thomas Robertson Sim, F.L.S., F.R.H.S., formerly Conservator of Forests for Natal.

ASSOCIATION LIBRARY.

The following publications are regularly filed at the office of the Association, Cape of Good Hope Savings Bank Buildings, St. George's Street, Capetown.

General Science.

Royal Society of Edinburgh: Proceedings.
Royal Society of South Africa: Transactions.
Royal Society of South Australia: Memoirs.
Royal Society of South Australia: Transactions.
Royal Society of Victoria: Proceedings.
Royal Society of Canada: Proceedings and Transactions.
Royal Society of Tasmania: Papers and Proceedings.
Royal Society of Queensland: Proceedings.
Royal Dublin Society: Scientific Proceedings.
Royal Institution of Great Britain: Proceedings.
Royal Philosophical Society of Glasgow: Proceedings.
Royal Society of Arts: Journal.
Michigan Academy of Science: Reports.
Chicago Academy of Sciences:
    Bulletins.
    Special Publications.
Atti della Reale Accademia dei Lincei. Rome.
Kungl. Svenska Vetenskapsakademien:
    Handlingar.
    Årsbok.
Koninklijke Akademie van Wetenschappen, Amsterdam:
    Proceedings of the Section of Sciences.
    Verhandelingen.
Revista de la Real Academia de Ciencias de Madrid.
British Association for the Advancement of Science: Reports.
Australasian Association for the Advancement of Science:
    Reports.
American Association for the Advancement of Science: Proceedings.
Indian Association for the Cultivation of Science:
    Proceedings.
    Reports.
    Bulletins.
Atti della Società Italiàna per il progresso delle Scienze.
Cambridge Philosophical Society:
    Transactions.
    Proceedings.
Manchester Literary and Philosophical Society:
    Memoirs and Proceedings.
American Philosophical Society: Proceedings.
University of California:
    Bulletins.
    Memoirs.

University of Virginia: Philosophical Society Bulletins.
Tôhoku Imperial University: Science Reports.
New York Academy of Sciences: Annals.
American Academy of Arts and Sciences: Proceedings.
Connecticut Academy of Arts and Sciences: Transactions.
Medelanden från K. Vetenskapsakademien Nobelinstitut.
California Academy of Sciences: Proceedings.
Academy of Science of St. Louis: Transactions.
Academy of Natural Sciences of Philadephia: Proceedings.
American Journal of Science.
Ohio Journal of Science.
Revue Générale des Sciences.
Archives Néerlandaises des sciences exactes et naturelles.
Annaes scientificos da Academia polytechnica do Porto.
Rhodesia Scientific Association: Proceedings.
Société de physique et d'histoire naturelle de Genève:
    Memoires.
    Comptes rendus.
Det Kongelige Norske Videnskapers Selskaps Skrifter.
Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger.
Istituto di geografia fisica e vulcanologica di Cantania: Publicazioni.
Vierteljahrsschrift der naturforschenden Gesellschaft, Zurich.
Imperial Institute: Bulletins.
New Zealand Institute: Transactions and Proceedings.
Annual Report of the Smithsonian Institution.
Annual Report of the Smithsonian Institution (United States National Museum).
South African Museum:
    Annals.
    Annual Reports.
Transvaal Museum: Annals.
Natal Museum: Annals.
Queensland Museum:
    Annals.
    Memoirs.
Field Museum of Natural History Publications.
University of Pennsylvania Museum Journal.
Bulletin of the Public Museum of Milwaukee.
Albany Museum:
    Annual Reports.
    Records.
Knowledge.
Science.

Chemistry, Metallurgy, and Geology.

Chemical, Metallurgical, and Mining Society of South Africa: Journal.
Kungl. Svenska Vetenskapsakademien: Arkiv för Kemi, Mineralogi, och Geologi.

Geological Society of South Africa: Transactions.
Geological Society of Tokyo: Journal.
Geological Survey of New South Wales:
    Reports.
    Memoirs.
    Mineral Resources.
Bulletins of the Geological Institution of the University of Upsala.
Abstracts of Proceedings of the Geological Society, London.
Bulletins of the Wyoming State Geologist.
United States Geological Survey:
    Bulletins.
    Professional Papers.
    Mineral Resources.
    Annual Reports.
Florida State Geological Survey: Annual Reports.
Union of South Africa Mines Department: Annual Reports.
Canada Department of Mines:
    Museum Bulletins.
    Memoirs of the Geological Survey.
    Reports.
Egyptian Ministry of Finance: Geological Reports.
Geological Survey of Western Australia:
    Annual Progress Reports.
    Bulletins.
Journal of Industrial and Engineering Chemistry.
Journal of Chemical Technology.
The Chemical News.
The Mineralogical Magazine
South African Association of Analytical Chemists: Proceedings.

Meteorology.

Quarterly Journal of the Royal Meteorological Society.
Bulletins of the Mount Weather Observatory.
United States Department of Agriculture: Monthly Weather Review.
Observatorio Campos Rodrigues:
    Relatorio.
    Resumo mensal.
Egyptian Ministry of Finance: Meteorological Reports.

Agriculture.

Annali della Regia Scuola superiore agricoltura di Portici.
International Institute of Agriculture, Rome.
    Bulletin of Agricultural Statistics.
    Bulletin of the Bureau of Agricultural Intelligence and of Plant Diseases.
Massachusetts Agricultural Experiment Station:
    Annual Reports.
    Bulletins.

Agricultural Gazette of New South Wales.
Department of Agriculture, New South Wales, Science Bulletins.
United States Department of Agriculture Experiment Station Record.
Journal of Agricultural Research.
Rhodesia Agricultural Journal.

Biology and Physiology.

Bulletin de la Société Imperiale des naturalistes de Moscou.
Kungl. Svenska Vetenskapsakademien:
 Arkiv för Botanik.
 Arkiv för Zoologi.
Journal of the Linnean Society, Botany.
Bulletin of the Wisconsin Natural History Society.
The Medical Journal of South Africa.
University of California: Publications in Botany.
Linnean Society of New South Wales: Proceedings.
Missouri Botanical Gardens.
 Annual Reports.
 Annals.
Bolus Herbarium: Annals.
Smithsonian Institution (United States National Museum):
 Contributions from the United States National Herbarium.
Royal Botanic Gardens, Kew: Bulletins.
Union of South Africa: Reports of the Director of Veterinary Research.
The Australian Zoologist.

Entomology.

Bulletin of Entomological Research.
Review of Applied Entomology.

Astronomy, Mathematics and Physics.

Royal Astronomical Society:
 Memoirs.
 Monthly Notices.
Journal of the Royal Astronomical Society of Canada.
Harvard College Astronomical Observatory:
 Circulars.
 Annals.
Union Observatory Circulars.
Observatoire Royal de Belgique; annuaire astronomique.
Bulletins of Khedivial Observatory, Helwan, Egypt.
Kodaikanal Observatory Bulletins.
Annual Reports of the Kodaikanal and Madras Observatories.
British Astronomical Association.
 Journal.
 Memoirs.
Lick Observatory Bulletins.

Nizamiah Observatory Reports.
Astronomical Society of India:
Journal.
Monthly Notices.
United States Naval Observatory Publications.
American Ephemeris and Nautical Almanac.
Proceedings of the Western Australian Astronomical Society.
Kungl. Svenska Vetenskapsakademien: Arkiv för Matematik, Astronomi och Fysik.
Proceedings of the London Mathematical Society.
Tôhoku Mathematical Journal.
National Physical Laboratory, Middlesex:
Collected Researches.
Reports.
Universidad Nacional de la Plata:
Contribucion al estudio de las Ciencias fisicas y matematicas.
Proceedings of the Physical Society of London.

Education, Political Economy and Sociology.

United Empire.
South Africa.
Ohio State University Bulletin.
International Institute of Agriculture, Rome: Bulletin of the Bureau of Economic and Social Intelligence.
Royal Dublin Society: Economic Proceedings.
Athenæum subject index to Periodicals.

Geography, Oceanography and Hydrography.

Società Italiana per il progresso delle Scienze: Comitato talassografico:
Bolletinos.
Memorias.
The Geographical Journal.
The Geographical Review.
United States Geological Survey: Water Supply Papers.
Egyptian Ministry of Finance: Survey Department Papers.
Istituto di geografia fisica e vulcanologica della R. Universita di Catania: pubblicazioni.
United States Department of Commerce, Coast and Geodetic Survey:
Special Publications.
Annual Reports.

Engineering.

Proceedings of the American Institute of Electrical Engineers.
Journal of the South African Institute of Engineers.
Transactions of the South African Institute of Electrical Engineers.
Proceedings of the South African Society of Civil Engineers.

Technology.

Patents for Inventions: Abridgments of Specifications.
The Illustrated Official Patents Journal.

Anthropology and Ethnology.

Journal of the African Society.

Archæology.

Bulletins of the Archæological Survey of Nubia.

PRESIDENT'S ADDRESS.

ADDRESS

BY

PROFESSOR JOHN ORR,

B.Sc., M.I.C.E., M.I.Mech.E.

PRESIDENT.

It is customary, in a presidential address, for the speaker to select a subject bearing more particularly upon his own professional work, but the questions of technical education and the progress of engineering have been dealt with by me on other occasions, and, apart from this, the affairs of the Association, and the abnormal times through which we are passing, provide subjects of such importance that it is impossible to ignore them.

At this, the fifteenth annual meeting of the Association, it may not be inappropriate to trace its progress and to give a short account of the way in which the objects of the Association have been fulfilled, recognising its shortcomings where such exist; and to deal with its affairs from what may be regarded as the material side.

In July, 1901, a meeting at Cape Town, called on the initiative of Mr. T. Reunert, decided upon an annual congress of engineers. After further discussion, it was decided to enlarge the scope and form an Association on the lines of the British Association—*i.e.*, that a congress should be held annually at various centres, and that different sections should be formed to cover the various branches of scientific and technical knowledge.

The movement met with immediate success. Office-bearers were elected in January, 1902, and although it was found impossible, owing to the disturbed state of the country, to hold a congress, there were 268 "foundation" members on the roll at the end of the financial year in June. The rapid growth of the membership and the extension of the Association's work led to the office work being divided—that in connection with the Transvaal, Orange Free State and Natal being directed from Johannesburg, while to Capetown were allocated Cape Colony, Rhodesia, and the rest of South Africa. To Mr. Reunert and Dr. Gilchrist (our medallist of this year), who undertook the pioneer work as honorary secretaries at these respective centres, must be accorded the unstinted praise of our Association.

The Association was fortunate in securing Sir David Gill, H.M. Astronomer for the Cape, as its first President, and much of the early success of the movement was undoubtedly due to his sympathy and guidance. In his presidential address at the first annual meeting at Cape Town in 1903, he made an earnest appeal for the claims of science: "It is not only a source of intellectual elevation and a high form of enjoyment to all who sufficiently interest themselves in its pursuit, but it also lies at the foundation of our civilisation and even of our existence." "And looking to the future prospects of scientific progress in South Africa," he continued, "I believe there is sound reason for the statement that these prospects are very hopeful, and the present a particularly suitable time for the inauguration of such an association as this."

Sir David Gill has passed away; but none of us who knew him can ever forget the lovable personality, geniality and thoroughly genuine character of this great man of science. His contributions to human knowledge have been great indeed, and some may think that this is the most fitting and only monument which a great man need have. Yet I think that this Association should perpetuate his memory by the erection of a permanent and visible memorial. A proposal was made by the Witwatersrand Council members during this year that the Association should undertake the collection of funds for this purpose. The matter is temporarily in abeyance, but I hope that at the annual meeting of members the proposal will be adopted, and Sir David's life's work suitably commemorated.

At the first annual meeting 48 addresses and papers were read, and the Cape Government of that day shewed its appreciation and sympathy with the movement by defraying the total cost of printing the volume of proceedings. Would that the

Union Government shewed its appreciation in such a tangible form!

It is clearly laid down that the first object of the Association is "To give a stronger impulse and a more systematic direction to scientific enquiry." Inspired by this object, the local Committee at Johannesburg, shortly after its formation in May, 1902, promoted a petition to Lord Milner, then High Commissioner for South Africa and Governor of the Transvaal, urging the establishment of an Observatory. As a result, the Transvaal Observatory and Meteorological Department was organised in 1903; in May, 1904, it was in full working order, and it was formally opened in January, 1905. At this date, owing to the state of the Transvaal finances, the Government was unwilling to spend money on astronomy, but before Union was consummated a small deputation of our members interviewed the Hon. Mr. Rissik, at that time Transvaal Minister of Lands, and he conceded an astronomical wing to the Observatory, and promised funds for the provision of the most powerful refracting telescope in the Southern Hemisphere. Unfortunately, the difficulties in the manufacture of the object glass, and latterly the great war, have delayed the completion of this telescope, but all the necessary funds have been allocated for it. After Union took place the Government decided that the Transvaal Meteorological Department should be enlarged so as to embrace the whole of the Union, and that its headquarters should be at Pretoria, whilst the Transvaal Observatory should be renamed the Union Observatory, and devote its attention more especially to the astronomical side. This Association can point with pride to its work in connection with the Union Observatory, which it can legitimately claim as its offspring, and equally can it claim the reflected glory of the scientific work and discoveries of that institution. During the career of the Transvaal Meteorological Department weather forecasts were issued daily, for the first time in South Africa, and this service has now become a permanent one.

The Association continued to progress materially to a marked extent. On the last day of the first conference at Cape town the membership stood at 765, including 41 associate members, while there was a balance at the bank of £300, a very creditable position for such a young Society.

The next annual meeting, held at Johannesburg in April, 1904, under the presidency of Sir Charles Metcalfe, proved a pronounced success. The total membership advanced to 1,073; 44 papers and addresses, many of great scientific and technical importance, were read; and through the generosity of the Transvaal Government, which voted £400 for the purpose, and the extraordinary liberality of the Mining Houses of Johannesburg, which subscribed over £900, the Association was able to print all these papers.

In the Constitution of the Association provision is made for the appointment of research committees, which have been a

prominent feature of the parent British Association. Although the regulations governing such committees are detailed under eight heads, it is disappointing to have to admit that no research committee has ever been appointed. But provision is also made for the award of grants to individuals, and at the Johannesburg meeting such grants in aid of research were made to:

Professor Pearson, South African College, £25 in aid of research on *Welwitschia mirabilis;*

J. Burtt-Davy, then botanist to the Transvaal Government, £50 to aid in the preparation of an annotated catalogue of the flowering plants and ferns known to occur in the Transvaal; and

R. T. A. Innes, of the Meteorological Observatory, £25 in aid of the work of preparing tables of the barometric pressures over South Africa and adjacent regions.

Every credit must be given to the Association for its efforts to assist the researches of its members in this way, and in continuation of this policy, in 1905, further awards were made to:

Dr. Roberts, of Lovedale, £100, to aid him in his work on variable stars; and

Dr. Gilchrist, £100, with a promise of a further £50 during 1906, to aid in the investigation of the fresh-water fishes of South Africa, including those of the Zambesi;

and during 1906 the following further grants were made to:

Professor J. C. Beattie, South African College, £100, to aid him in his work on the magnetic survey of South Africa;

Professor Duerden, Rhodes' University College, £45, to aid him in his investigation on tortoises; and

J. Stuart Thompson, to aid him in a research of South African Alcyonaria.

And then the shoe began to pinch. In the report of the Council, in August, 1905, an appeal was made for the payment of subscriptions on the ground that lack of funds prevented the Council from "carrying out one of the main objects of the Association, *viz.*, the granting of money for original research work.

In the report for the year ending July, 1908, the failure to acknowledge this appeal led the Council to deliver a few valedictory remarks on the subject of grants-in-aid of research.

The Council regretted that, owing to the great falling off in revenue, they were unable to authorise the completion of the grant to Dr. Beattie, and he was thanked for having generously waived his claim to the balance.

Mr. Burtt-Davy was informed that they were unable to accede to his request for a grant-in-aid of £100 for three years to assist him in having the botanical specimens in the Kew Herbarium worked up.

Dr. Gilchrist was informed that, owing to financial reasons, the Council regretted it was unable to fulfil its promise made to him for a further grant, but thanked him for having generously relinquished his claim on the funds of the Association.

Fortunately, Dr. Roberts was able to complete the work of 20 years before the financial crisis arrived, but Dr. Duerden had to be content with regrets that for financial reasons the Council was unable to authorise payment of his grant, so that tortoises would have to be investigated without the assistance of the Association.

Money must be found for a research fund if the Association is to justify its existence. Certain of our Cape Town friends suffer from a super-sensitiveness, and consider it undignified for a Science Association to make an appeal for such a sordid thing as money. Their Johannesburg colleagues do not share their modesty. It has only been by such appeals that the Association has been kept from extinction during the past few years. Those who acquire in a business capacity the fruits of science, and make fortunes commercially from the efforts of scientific men, should consider it an honour to be allowed to contribute from their accumulated wealth.

The American Association for the Advancement of Science has a permanent fund of nearly 100,000 dollars, the income from which is appropriated to aid research. It was founded 70 years ago, and, with a total membership of nearly 11,000, its annual meetings constitute the largest and most important gatherings of scientific men held in any part of the world. And yet it does not hesitate to make direct appeals for members and money.

An appeal in connection with the New York meeting of December, 1916, says: "Contemporary history has made evident to all the dominant place of science in modern life, and has, at the same time, placed upon us the responsibility of leadership. New York City may become the world's financial centre; it is even more important to us as a nation that the New York meeting of the Association shall signalise the period at which our country becomes the most fruitful centre of scientific research. The applications of science, by doubling the length of life and quadrupling the productivity of labour, have made possible universal education and equality of opportunity. Science and education have given us democracy; it is the duty and privilege of democracy to repay its debt by forwarding science and education to a degree not hitherto known in the world's history."

"Science can only be supported in a democracy as the result of the organisation of scientific men. We cannot depend upon a leisured class, as has been the case in England, nor upon governmental organisation, as has been the case in Germany. Science, with its applications, has given the world its vast wealth, but the results of research, being for the benefit of all, and not, as a rule, for an individual or group, must be paid for by society. Scientific research is purchasable, but it must be supported by endowments or by national, State, and municipal appropriations. The career of the scientific man must be made attractive in order that able men may follow it. Science requires recruits, and it requires money. These are only to be obtained by impressing the public, the press, and the Government with the supreme im-

portance of scientific research. One of the most effective means is the organisation of scientific men into associations for the promotion of their interests, which are identical with the interests of society as a whole."

During the past year I accompanied a deputation of Transvaal members of Council, who waited upon the Minister of Mines and Industries, with a view to obtaining an annual grant from the Government, so as to place the finances of the Association on a satisfactory basis. We were courteously and sympathetically received, but no grant has so far been forthcoming. We shall try again.

Now let us leave the painful subject of comparative failure and resume the story of the Johannesburg meeting. In connection with this session, a small loan museum was organised, and this proved so successful that the local Council members formed a Committee, to which was added representatives of the various scientific and technical societies and public bodies. The Association gave £25 towards the initial expenses, and the Witwatersrand Council of Education subscribed £100, but the movement languished for want of funds, and the hopes of the Committee have been doomed to disappointment. Government grants are made to museums at Cape Town, Pretoria, Pietermaritzburg, and Port Elizabeth, but Pretoria, which has a National Museum, is only 35 miles from Johannesburg, and, as there is more than one train a day, it may be thought that the needs of the largest population and of the greatest city in the Union are fully met. The Johannesburg museum, which is mainly of a geological character, still exists, however, thanks to the generosity of the municipality, and there is still some hope that it may emerge as a technological museum worthy of the Rand.

The visit of the members of the British Association for the Advancement of Science to South Africa in 1905 constituted an epoch in the history of our Association. Sectional meetings of the South African Association were not held, these being merged in those of the British Association. A handbook on scientific work and progress in South Africa, entitled "Science in South Africa," was published, under the editorship of Drs. Flint and Gilchrist, in connection with this visit, the South African Governments defraying the cost of publication, while the work of the contributors was entirely voluntary.

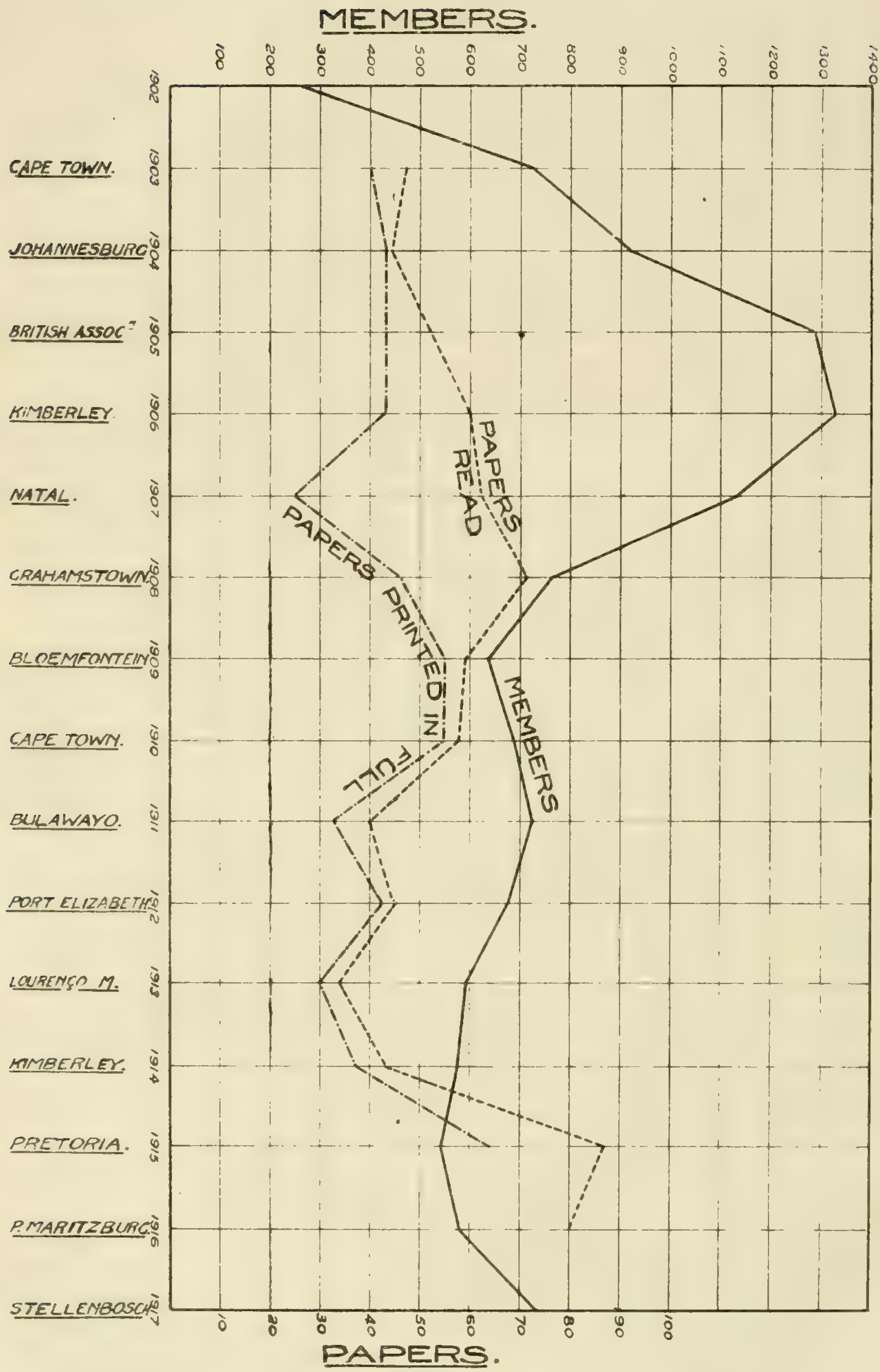
Meetings, at which papers and addresses were read, were held at various centres, and in the words of the British Association President, Professor Darwin, "the total contribution to science, especially as applicable to Africa, has proved to be of considerable magnitude." The records of this historic meeting are to be found in four handsome volumes, and it is pleasant to record here the extreme liberality of the various South African Governments of that day. In addition to providing free railway passes for the officials and visitors, a sum of £6,000 was guaranteed towards the cost of their passages. In addition, the Trans-

vaal Government gave £400 towards the publication of the four volumes of proceedings, but these were the days before Union!

The visit of the British Association gave an impetus to our own, and the membership, on the 30th of June, 1905, reached 1,289.

One important outcome of the British Association's visit was the institution of the South Africa Medal and Grant, the funds for which were raised by that Association in commemoration of its visit. The award is made for "achievement and promise in scientific research in South Africa." Eight awards have now been made, and it is interesting to note that the recipients have included a bacteriologist, three botanists, a physicist, a zoologist, an astronomer, a geologist, and an entomologist, while the ninth award will be made this evening to a distinguished zoologist.

The high-water mark in the history of the Association was reached in 1906 at the Kimberley meeting, when the membership totalled 1,322. If we trace its history from the membership point of view, we find the following: Pietermaritzburg and Durban meeting, 1907, 1,032 members; Grahamstown, 1908, 767; Bloemfontein, 1909, 637; Cape Town, 1910, 693; Bulawayo, 1911, 719; Port Elizabeth, 1912, 673; Lourenço Marques, 1913, 594; Kimberley, 1914, 579; Pretoria, 1915, 547; Pietermaritzburg, 1916, 584; while we have, at the conclusion of this meeting at Stellenbosch, 740 members. The figures, together with the number of papers read and printed in the journal, I have shewn by curves, but I do not suggest that the number of papers read is a measure of the intellectual activity of the Association. It is gratifying to find that the membership is now greater than it has been since 1908, in spite of the abnormal times, but still it is far from satisfactory, and shews a deplorable want of interest, which is seriously crippling the work of the Association. Why, for example, should Grahamstown, a University centre, and a recognised seat of learning, be able to produce only nine members? It is absolutely necessary, if this Association is going to continue its existence, that a policy of greater activity be instituted and maintained. Every year we listen to the Honorary Treasurer's lament; we know that all honorary treasurers are prone to adopt a pessimistic attitude, and ours is no exception, but let us gladden his heart by bringing in recruits. Only new members and their subscriptions will keep this Association alive. We cannot live on doles. With a large and active membership, we have greater justification in appealing as a right to the Government for an annual subsidy. We cannot keep on appealing to the mining houses of Johannesburg to help us out of our difficulties; the Witwatersrand Council of Education, which has been an excellent milch cow, has now run dry; we cannot accept the hospitality of Stellenbosch, and then ask the town to contribute towards the cost of publication of our proceedings as we have done with success elsewhere. Owing to financial embarrassment, the Association has had on many occasions to remain


MEMBERS.
100
200
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1200
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1400
1902
CAPE TOWN. 1903
JOHANNESBURG 1904
BRITISH ASSOC^n 1905
KIMBERLEY 1906
NATAL. 1907
GRAHAMSTOWN 1908
BLOEMFONTEIN 1909
CAPE TOWN. 1910
BULAWAYO. 1911
PORT ELIZABETH 1912
LOURENÇO M. 1913
KIMBERLEY. 1914
PRETORIA. 1915
P. MARITZBURG 1916
STELLENBOSCH 1917
PAPERS READ
PAPERS PRINTED IN FULL
MEMBERS
10
20
30
40
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60
70
80
90
100
PAPERS.

in the background instead of leading scientific thought and movement.

A crisis in the Association's financial affairs was reached in 1908, and to reduce administrative expenses it was decided at the Bloemfontein meeting to centralise the offices at Cape Town, and to publish the proceedings in a monthly journal. The JOURNAL OF SCIENCE has served as a connecting link between the members, but the hopes of a revenue from advertisements have not been fulfilled; in this respect the support of the commercial community has been most disappointing.

Reference to the Constitution will show that provision is made for the appointment of Standing Committees, and such Committees to deal with education and anthropology were formed in November, 1905. The object of the former was to collect and collate statistics relating to education in South Africa. A report was presented to the educational section at the Natal meeting in 1907, but for some reason—probably financial—it was not printed in the proceedings. It did not meet during 1908; reference is made to it in 1909. It was announced at Cape Town in 1910 that it was still in existence; at Bulawayo in 1911 it was lamented that no report had been received regarding it or any other Committee for three years, and that is the last reference I can find about it in our proceedings. It does not appear, however, to have been dissolved, and, now that education is so much to the front, perhaps at this seat of learning we might resuscitate it.

The Anthropological Committee was more fortunate. It secured publicity in the proceedings for two short reports in 1907 and 1908, mainly, however, outlining its objects and aims. In 1913, nothing further having been heard from the Committee, the sum of £20, voted on its behalf by the Transvaal Government in 1909, was awarded to Miss Tucker to assist in her Anthropological research.

There is some mystery attaching to the standing committee on Forestry; its existence is announced in the annual report for 1909, but I have been unable to find in the proceedings any trace of the personnel, and no report has yet been received. It is dealing with a subject of momentous importance to South Africa, and its report is keenly awaited.

The second object of the Association, as given in the Constitution, is "to promote the intercourse of Societies and individuals in different parts of South Africa." In carrying out this object, and in claiming the support of all interested in science and its furtherance, the Assosciation is in the unique position of—(1) representing all branches of science and technology; (2) being geographically all embracing, its members hailing from Cape Agulhas in the South to the Zambesi in the North, from Mozambique in the East to Walfish Bay in the West; and (3) holding its annual meetings at all importanat centres of South Africa, including Rhodesia and Mozambique, and so is in a

favourable position to co-ordinate all interests. This is well exemplified by the success which attended the Metric Conference, held at Johannesburg in April of this year. It will be recollected that certain resolutions dealing with the adoption of the Metric System, Decimal Coinage, and "Daylight Saving" were passed last year at Pietermaritzburg on the initiative of the Union Astronomer. After receiving the practically unanimous support of the Council, they were forwarded to the Government and public bodies specified. The Witwatersrand members felt that in order to strengthen the hands of the Government, and to have these very necessary reforms put into effect, it would be necessary to bring to bear the combined weight of opinion of the various scientific and technical societies and public bodies in South Africa. A conference was, therefore, organised, and was attended by nearly 60 delegates, representing 34 societies and public bodies from all parts of the Union, as well as Rhodesia. The resolutions adopted are given in our annual report, and need not be repeated here.

They were referred for confirmation by the various Societies represented, with the result that the first and second resolutions dealing with the adoption of the Metric System and the Decimalisation of the Coinage, were unanimously adopted, while only two Societies dissented from the third, advocating the fuller use of daylight. I will not enter into the arguments; it is hoped that a full report of the Conference will be published in the JOURNAL OF SCIENCE.

Another resolution, which emanated from Natal, asked the Association to take the following steps in order to make the Metric System and its advantages more generally known in South Africa:

(*a*) That popular lectures be given in the larger towns explaining the system, and enumerating its advantages. At the lectures the local member of the Legislative Assembly should be asked to preside.

(*b*) That Municipalities be circularised and asked to purchase complete sets of commercial metric weights and measures for exhibition in their museums.

(*c*) That a booklet on the Metric System, specially written for South Africa, be prepared for free circulation or for sale at a nominal figure.

Nothing has yet been done to put these resolutions into force—the financial question has again intervened—but the matter will be discussed at our annual meeting of members.

The question of the closer working of Scientific and Technical Societies is one which has been receiving considerable attention during the past few years, and certain proposals with regard to the formation of a Federal Council of Scientific Societies will, I understand, be brought up for discussion during our meetings.

A year ago a Board of Scientific Societies, consisting initially of representatives of 27 scientific (including technical) societies, was formed in Great Britain, with the object of promoting the co-operation of those engaged in pure and applied science; supplying a means by which the scientific opinion of the country may, on matters relating to science, industry, and education, find effective expression; taking such action as may be necessary to promote the application of science to industries and to the service of the nation; and discussing scientific questions in which international co-operation seems advisable. An example of what can be done by co-operation is evidenced by the Central Committtee of Scientific and Technical Societies, formed at Johannesburg in April of last year, which greatly facilitated the formation of the Government Committee on Scientific and Technical Research. Such co-operation seems eminently desirable.

The question of a convocation week for all South African Scientific and Technical Societies was mentioned at last year's congress, but no decision was arrived at. The idea was introduced at the Johannesburg meeting in 1904 ,when a conference of librarians of South Africa was arranged. It may be that South Africa is not sufficiently developed for such a scheme, but it may be useful to consider for a moment the position of America. There, 51 National Societies meet regularly or at times with the Association for the Advancement of Science. the work of which is organised in twelve sections, covering the field of pure and applied science, and 30 of the Societies are affiliated and have representation on the Council of the Association. The principle of affiliation was accepted at our last annual meeting, but the details have still to be agreed upon.

The third object of the Association is "to obtain a more general attention to the objects of pure and applied science, and the removal of any disadvantages of a public kind which may impede its progress." To a limited extent this object has been kept in view, with varying success. Several activities were mentioned by Mr. Reunert in his presidential address at Johannesburg; these included efforts to establish a Botanic Garden and Arboretum for the Transvaal, to be managed purely as a Government institution; a Forestry School and a Military College for South Africa; the systematic collection or preservation of objects of scientific or historic interest; the encouragement of nature study in schools; a scheme of University extension lectures; and the preparation of a series of memoirs on men of science and other South African men of note. In 1907 an effort was made to get the Transvaal Government to establish a Standardising Laboratory, but without success. About the same time a Committee dealt with the standardisation of weights and measures in South Africa.

Success attended the Association's efforts to establish a National Botanic Garden, which was recommended at the Cape-

town meeting in 1910. Professor Pearson outlined a scheme in his presidential address to Section C, and shortly afterwards it was announced that Dr. Bolus had presented his valuable herbarium. The Council re-affirmed, in May, 1913, its resolution that "such an institution would greatly advance the scientific and economic study of the vegetation of South Africa," and it was announced at the Lourenço Marques meeting in that year that Parliament had sanctioned the scheme.

In connection with the meteorite which was observed to fall in the N'Kandhla district, Zululand, in August, 1912, and which unfortunately has been lost to South Africa, a resolution was passed at the 1913 meeting, asking the Government "to pass legislation declaring that meteorites are Government property, and that when found they should be delivered to the nearest magistrate for transmission to the nearest museum under Government control." The Secretary for the Interior, however, replied that the proposal could only be considered if sufficient reasons in support were supplied. Dr. Juritz, who was present at the joint meetings of the British and Australasian Associations in Australia in 1914, brought the question forward, and the action of our Association was subsequently endorsed by the Council of the British Association, which passed a resolution "that in view of the fact that meteorites, which convey information of world-wide importance, are sometimes disposed of privately, the Council be requested to take such steps as may initiate international legislation on the matter." This resolution was transmitted to the International Association of Academies, but owing to the war, there the matter now rests. There is still the risk that such invaluable relics may find their way into the hands of foreign dealers, to be retailed in small slices at enormous prices.

During the past year, on the initiative of Miss Wilman, the Witwatersrand Council members pointed out to the Government the advisability of passing a law which would prevent rare fossils and ethnological remains of national interest from leaving South Africa, without the authority of the Minister of the Interior or some responsible officer. It may be claimed by some that such restrictions would not be in the general interests of science, but similar regulations exist in other countries, and even Mexico prohibits the export of antiquities.

The reptilian fossil remains which have recently been removed from South Africa are housed in the American Museum of Natural History, New York, and are fully described in the American Museum Journal of December, 1913, and April, 1914. It is stated that from fifty to sixty types have been added to the fifty-two types of Permian reptiles already in the American Museum, and an invidious comparison is made with the British and Capetown Museums. "It is so rich in types," it is claimed, "that it rivals the British Museum collection, while from a spectacular point of view, it surpasses that collection, as well

as the collection in the Capetown Museum, for apart from its types, it has an unusually large number of representative specimens, and those in unusually perfect condition."

The matter was brought to the attention of the Minister of the Interior at a time when there was some possibility of preventing the exportation of irreplaceable fossils of great national interest, and pressure was brought to bear privately on parliamentarians of influence, but nothing has been done. It is now too late to deal with the specimens referred to, but it is to be hoped that the Government will realise the importance of retaining in the future such relics for South Africa.

An event of considerable importance was the grant in 1906 of £500 from the Witwatersrand Council of Education for the purpose of University extension lectures, the administration of this, and subsequent grants being left unconditionally in the hands of the Johannesburg members of Council. With this generous assistance, series of lectures were delivered at the principal towns of South Africa during the four years from 1907 to 1910 by eminent authorities from Great Britain. It is of interest to note that the lecturer for 1908 is now President of the Board of Education in the new British War Cabinet. Unfortunately, for various reasons, these lectures were discontinued in 1910.

The Association has always been keenly interested in University education. At the Kimberley meeting in 1906, the question was discussed at a joint meeting of sections, and it is proposed at this Conference to raise the question of University Education, with special reference to a memorandum on the subject which has been prepared by the Witwatersrand members.

In 1907 the Council made provision for the formation of local branches, by which interest might be more fully maintained in the intervals between the annual sessions. Some of the branches have been fairly active, and have arranged for local papers and addresses, but, on the whole, the scheme has not met with much success. A few years ago the Johannesburg members of Council agreed to hold a conversazione in honour of any distinguished scientist who might visit the Rand, and in this way Sir Almroth Wright and Col. Gorgas and his staff have been honoured.

In order to arouse a greater interest in science amongst students, the Council decided, in 1906, to inaugurate a prize fund. Sir Hamilton Goold-Adams, the President for that year, generously provided a die, and five Goold-Adams medals are now awarded annually on the results of the Senior Certificate and Matriculation Examinations in science subjects.

At the first meeting of the Association, Professor Hahn drew attention to the neglect of science teaching in schools. "It is hardly credible," he said, "but nevertheless it is a fact, that the University regulations allow this neglect of the study

of science in this country, of which the future depends, in the first place, upon the development of its natural resources, which require, above all, a thorough and comprehensive knowledge of science, which should be part and parcel of the education of every South African." He was referring particularly to the fact that science was an optional subject for the Matriculation Examination of the University of the Cape of Good Hope; it was reinstated as a compulsory subject in 1909.

A pamphlet entitled "The Neglect of Science," which has been widely circulated during the last year, gives a report of a meeting, attended by a hundred and fifty of the most prominent scientific and technical men in Great Britain. The object was to urge upon the Government the necessity of a full recognition of science in schools and colleges and in the examinations for the Civil Service. Grave blunders, committed at the beginning of the war through the absence of a scientific training on the part of Ministers, were emphasised and, incidentally, the retentions of Classics as a predominating subject was generally condemned. How engineers and manufacturers view this controversial subject may be gathered from the following remarks of a writer in the technical press when referring to after-war problems:—

> Reforms cutting deep into all past beliefs and prejudices will be necessary. Education must be wider and be in closer touch with the actualities of life. No longer must the phrase "a liberal education" imply a familiarity with dead languages and an ignorance of living ones, an ability to quote classic authors and an ignorance of the rudiments of science, a familiarity with manners and etiquette and an ignorance of the ways in which the masses toil and earn their daily bread. Older methods of training must be discarded. The acquisition of knowledge must be a means to an end, and that end increase in industrial efficiency.

No one would, however, suggest the total discarding or neglect of cultural subjects, which are essential for the development of all that is best in character.

For a young and sparsely-populated country such as ours, we can scarcely say that the Government has neglected the claims of science; the complaint will probably be that it has not gone far enough. By his research work into animal diseases, Sir Arnold Theiler, our President of 1912, has rendered invaluable service to the pastoral interests of this country. Yet a few months ago he found it necessary to voice a strong plea for an increased staff of properly paid veterinary surgeons to enable his work to be continued efficiently. Considering the vast amount of the interests at stake and the rapid rate at which the pastoral interests are developing in this country, which has great ambitions in the direction of an important meat export trade, it is surely a short-sighted policy to stint a department such as that of the Director of Veterinary Research, which has saved such enormous sums to the nation by the prevention of animal diseases.

Our Government, I am afraid, has not always fully realised

in the past the powerful aid of science and scientific research in general and industrial development. It has been following too much the lead of Great Britain, and has been perhaps too much inclined to regard the scientific departments of the Government as not of primary importance, since they are not immediately productive in the commercial sense. The totally inadequate salaries paid to the personnel of Government scientific departments is perhaps an indication of the place which their work has occupied in the general plan of the nation. Only recently a protest was made in connection with an advertisement for a mycologist—who had to be a University graduate—at the princely remuneration of £180 per annum. Science may be its own reward, but even the poor scientist must live.

But all this is going to be changed. Science has gained immensely in prestige since the war began. The consequences of the neglect of science and technical training have been brought home to such an extent, that terrible as that conflict is, there can be no question that it has served to vitalise, as nothing else could have done, the British nation; and, perhaps, the greatest lesson of the war has been the realisation of the necessity of greater scientific methods in relation to industry. The appeals of scientific and technical men, which have so often been disregarded by apathetic, self-satisfied and conservative manufacturers, pursuing rule-of-thumb and obsolete methods, and, by their inaction, allowing so often the fruits of British brains to be exploited in Germany, would now appear to be falling on receptive ears, and we welcome the prospect of a new era for science and scientific methods. We must realise that the whole fabric of industry is based on science, and Governments are now recognising it as their duty to embark on a more enlightened policy by promoting scientific research on a national scale. It is for associations such as this to see that the new ideals are maintained.

The Union Government established, about a year ago, an Industrial Advisory Board of business men, to which a technical member was at a later date added. But as a result of the representations of the Central Committee of the Scientific and Technical Societies of South Africa, on which this Association was fully represented, the Government agreed in March of this year to the appointment of a Scientific and Technical Research Committee to assist the Industries Section of the Department of Mines and Industries in providing for Industrial Research, coordinating, as far as possible, all industrial investigation and research in South Africa, and collecting and disseminating all data obtained; in co-operating with other Government Departments, and with similar departments in the United Kingdom and Dominions to obtain information already available, so as to avoid overlapping, to take advantage of facilities for research not available in this country, and to acquire and utilise in the arts and manufactures knowledge already existent in countries which are more highly developed industrially than South Af-

rica; in carrying out an economic survey of the natural resources of South Africa, and in furnishing advice in regard to the best methods of utilising such resources; in furnishing advice with regard to the best method of attacking industrial problems; in inducing industrial improvements and facilitating and encouraging manufactures in suitable localities; in co-ordinating various industries to obtain the best combined results and exchanging between user and manufacturer manufacturing improvements and operating experience; and generally in advancing the work of the Department on the sicentific and technical side.

The action of the Government in advertising for a technical adviser, at a salary commensurate with the importance of the position, is one which must be cordially welcomed as an indication that it realises the importance of the present movement.

The Scientific and Technical Committee held its first meeting at Capetown in April of this year. The published list of fifty-two subjects on which it is proposed to obtain the earliest and fullest existing information from the most competent authorities available, gives some idea of the programme which the Committee has outlined apart from an indication of the latent potentialities of the Union as a manufacturing country. Time forbids detailed reference, but it will be observed that the investigation of raw materials and products from the agricultural and pastoral industries, together with various valuable bye-products, hitherto neglected, bulk largely amongst the subjects.

It is of some interest to note that all the ten members of the Committee are members of our Association, and that five are members of the Council.

The Union Government has followed the policy adopted by the British Government, which in July, 1915, formed a Committee of the Privy Council, and constituted an Advisory Council for Scientific and Industrial Research. The first report of the Advisory Council, issued last September, is worthy of the most serious consideration; it has been stated that a million sterling per annum is to be appropriated to promote its objects.

Referring to the absolute necessity of promoting and organising scientific research, with a view to its application to trade and industry, the report says:

> It needed the shock of the war to make the need manifest. The outbreak of war found us unable to produce at home many essential materials and articles. We were making less than a couple of dozen kinds of optical glass out of over a hundred made by our enemies. We could hardly make a tithe of the various dye-stuffs needed for our textile industries, with an output of two hundred and fifty million sterling a year. We were dependent on Germany for magnetos, for countless drugs and pharmaceutical preparations, even for the tungsten used by our great steel makers, and the zinc smelted from the ores which our own Empire produced.

After reviewing, at considerable length, the position in Great Britain with regard to technical education, facilities for research, the general position with regard to industrial concerns

and the attitude of such towards research, the Committee summarises the conditions for the success of its work as: "First, a largely increased supply of competent researchers; secondly, a hearty spirit of co-operation amongst all concerned, men of science, men of business, working men, professional and scientific societies, universities and technical colleges, local authorities and Government departments" "And neither condition will be effective without the other," it adds. The report shows that before the war the output of the Universities was altogether insufficient to meet even a moderate expansion in the demand for research. The war has depleted them of their students and teachers, and the view is expressed that the number of trained research workers, who will be available at the end of the war, will not suffice for the demand which they hope will then exist.

A Board of Education Committee, in a report issued last July, declares that to stint education, study, or research, would be the worst of all possible forms of economy, and that it is certain unless more effort, more thought, and even more money are spent upon education after the war than before, we shall not regain or retain our place among the nations. On its recommendation a huge sum has been set aside for scholarships, both for secondary and university education, but stress is laid upon the necessity of managers of industry and commerce recognising the value of scientific training in their advisers and as an important qualification for directive posts.

While making it clear that research in pure science should be as much their care as research in applied science, the British Advisory Council decided to give science, in its application to industry, precedence over pure science in their deliberations, and that any effective encouragement of pure science must await the return of peace.

"The Universities," the report says, "can and must be the main sources of research in pure science, the discoveries of which lie at the root of practical and technical application. Yet Universities will not be able to do their fair share of this vital service unless they can attract more students and larger funds. . . . Unless our Universities are in a position to offer appointments which carry with them real freedom from financial anxiety, it is certain that their teachers will not, because they cannot, take the leading part which they should in the national contributions to knowledge."

In discussing the important question as to whether the Universities can undertake industrial research work, attention is drawn to the research departments, which have been established by large American firms, and to the research institutes of Germany, which provide for special investigations of a longer or more elaborate kind than those which can be undertaken by University students and teachers.

"The fact is," the report stated, "that although the German Universities and technical schools have been able in the past to

do much for the industries, because their professors have had little routine work to do in comparison with British standards, the increasing complexity and length of the research necessary for modern scientific manufacture is making it increasingly difficult for the Professor or the University laboratory to take a dominating share in the advance." But the advantages of a close co-operation between the industries and the Universities are fully recognised. "In the first place, it will be easier to attract the support of the trades if provision is made for training their higher staff as well as for investigating their difficulties. In the next place, it ensures the continued contact of the research worker with advanced students—an inestimable benefit in the opinion of all the best authorities. Finally, it enables us to use to the utmost advantage the very limited number of original workers, available for either research or for teaching."

As to whether the functions of the Universities can be extended beyond that of providing trained research workers, to include the industrial requirements of the research itself, the Council maintains an open mind. "In some cases now before us," it states, "it will probably be the best way of proceeding; in other cases, where a powerful industry and many complicated problems are concerned, it may not."

Recently the Director of the National Physical Laboratory has complained of the totally inadequate financial support received from the Government. The present annual grant is £7,000, but during the fifteen years of its existence, it has received a total of only £59,000, as compared with £70,000 given annually by the Germans to corresponding institutes at Berlin, and the sum of £100,000 received every year by the Bureau of Standards from the United States Government. I mention these facts to show what research work costs; it would be useless for the Union Government to establish a similar institution, unless it is prepared to supply it with funds on a most liberal scale.

In view of the adverse criticism which has been frequently made against British scientists and the comparisons which have been made with the Germans, it is reassuring to find such an important body as the British Advisory Council for Scientific and Industrial Research expressing the opinion that: "Our people have no reason to fear or envy the scientific pioneers of other races. They have had, and will probably continue to have, their full share of the outstanding minds to which each century gives birth."

What has been done in technical education here goes to prove that the South African born—including sons of Stellenbosch—are capable of occupying the highest technical positions which this country can offer. South African trained engineers are welcomed in the works and laboratories of leading European and American firms. For example, the General Electric Company of Schenectady, U.S.A., spends over £100,000 every year on research, and employs a staff of 200 trained scientists in their

laboratories and test departments. At the present moment there are five South African trained engineers undergoing a two years' post-graduate course with that firm—four from the South African School of Mines and Technology and one from the South African College—and, from authoritative information which I have received, they are doing exceedingly well.

It is not my intention to attempt to deal fully with the many problems with which South Africa teems, even those which bear on the development of our great country. Unfortunately, many of our problems have, for some reason or other, been converted into political questions, and at this non-political gathering, anything savouring of politics must be rigidly excluded. Mr. Merriman has said that there is too much politics in this country; those who belong to no political party will, I think, agree with him. Almost every man and woman in South Africa is a politician, and we send 41 lawyers to Parliament. One of our members who combines the pastime of ardent sociology with the professional pursuit of science, advocates government by function, according to which the only reason for sending a man, or woman, to Parliament, would be special fitness as an expert on some particular subject, or as a representative of some particular interest. Political cleavages are not doing this country any good. Let the advice of the Administrator of the Orange Free State be taken in the spirit in which it has been offered: "Last year," he is reported to have said, "the Union imported leather goods to an amount almost equal to that which farmers got for their wool. Whilst they were quarrelling about small matters, they were really forgetting the things that mattered. Each year grain to the value of £1,500,000 was imported, although the South African climate was excellently suited for grain production. When it was dry they prayed for rain, but, when the rain came, millions of tons of water were allowed to run to waste to the sea. . . . Europeans were only comparatively few in South Africa. Why, then, should they continue quarrelling instead of developing their country?"

Apart from the native question, efforts to solve which have recently been made, the principal questions upon which public attention is being focussed, and which have recently been frequently discussed in Parliament, are the necessity for the increased production of food supplies within the Union and of the raw materials required in the manufacture of articles of consumption, so as to render South Africa more independent economically; the scientific and economic survey of the natural resources and potentialities of the Union, in a serious effort to ascertain what is available in the form of raw materials for active industrial exploitation, so as to develop industries using these raw materials instead of, as has been so much the practice in the past, exporting them and repurchasing the manufactured articles at greatly enhanced prices; and incidentally, what is of the greatest national importance—the training of the young citi-

zens of this country to take their place as competent workers in these industries.

The report of the Boer delegates, sent on a tour twelve years ago, said: "The only thing needed is energy, patient and persistent. Other colonies have been visited by drought and famine, frosts and hailstorms, but they have in a large measure conquered or controlled these difficulties by the resolute will of the people, encouraged by a wise, far-seeing Government. We look forward confidently to the day when we shall not only produce sufficient to support the whole of South Africa, but also take a proud position in the markets of the world."

To a limited extent these hopes are beginning to be realised. A close study of the latest Customs returns shew that South Africa is passing through the importing to the exporting stage, though they also shew that much is now imported which could, without much difficulty, be produced in South Africa. It must not be forgotten, however, that the war has had a wonderful effect in stimulating the agricultural and pastoral interests of this country, by providing protection which no tariff wall could ever give, *viz.*, the prohibition of imports from oversea, and difficulties connected with shipping, involving increased freight and insurance charges. But while we welcome earnest and sustained efforts on the part of the agricultural and pastoral community to make South Africa more self-reliant as regards its food supplies, there is at the moment the much higher and patriotic motive, of assisting the Mother Country in consort with the other self-governing Dominions, in the great struggle, by reducing the demand on her raw materials, manufactures and foodstuffs, while straining every effort to increase our exports to her. It is the duty of every producer to realise his individual responsibility in this matter.

Never has South Africa had such an opportunity as the present, when the extraordinary increase in the consumption of the essentials of life in Europe is accompanied by a decrease in production. And it must be remembered that the demand for such will not cease when peace is declared, since the world will be faced with a shortage for years, so that a stimulation of effort now, when such abnormal protection to agricultural products exists, will give an impetus to agriculture in this country, which will be permanently felt, apart from the building up of a large export trade.

It is fashionable to decry the farmer for want of enterprise, but critics should remember that farming in South Africa is to a great extent a speculative venture. No one should complain of any encouragement given by the Government to agriculture, for agriculture must become and must remain the staple industry in this country. Fortunately, South Africa does possess many progressive farmers, and there are many indications of an improving outlook. The great improvements which have taken place in stock and in agricultural produce have been clearly

shown at recent agricultural shows. But, unfortunately, there are many exceptions. We require more up-to-date methods and a greater appreciation, on the part of such, of the advantages to be gained by the application of science to agriculture. Academic discussions in Parliament will not bring out the potentialities of the soil, which can only be achieved by concentration of effort and persevering energy, directed by a policy of enlightened scientific method. It would be useless to claim that such a policy has been generally followed in this country. Agriculture here has undoubtedly many drawbacks, and the progress of the farmer has been greatly hindered by drought, flood, stock disease and other causes, but how often do we hear that the farmer will not avail himself of the helping hand offered, and take advantage of the expert assistance which the Government places at his disposal? We have but to think of locust destruction and the eradication of scab in sheep.

The whole land abounds with examples of neglected opportunities. The Government has repeatedly made the statement that it cannot start industries; it can only give advice. And when we consider for a moment what has been done through its Agricultural and Lands Departments, unbiassed observers must admit that advice has been showered upon the farmer in such profusion that it has come to be a source of irritation to those engaged in other industries, who accuse the agricultural interests of receiving undue preference. Frankly, we must admit that the farmer in many instances has not made the most of his opportunities. The recently issued reports of the Dominions Commission draw attention to the way in which Canada and Australia have been developed into great producing and exporting countries—it dwells on the wonderful external trade expansion of Canada, which has increased 190 per cent. between the years 1900 and 1913—and emphasises the need for greater population which, of course, means throwing open the land to the newcomer. As the member for Stellenbosch has somewhat caustically said, we have "stoep-sitters at one end and poor whites at the other, and that state of affairs is not in the interests of the country. . . . Here the farmer waited for an Act of Parliament, and then often kicked at it." No one can object to the Government assisting in every possible way those who are honestly endeavouring to increase the productiveness of the country, and even to assist financially the victims of misfortune, but the manifestation of a spirit of greater self-reliance and progressiveness on the part of many would be greatly welcomed by those who frequently complain that there is too much pandering to the agricultural interests. Unwillingness on the part of South Africans, by nativity and adoption, to meet the situation and exert their utmost endeavours in well-directed channels, can only lead to the surrendering of their opportunities to those more amply qualified by energy and initiative.

The cry of the world is for greater production. The war

has taught Great Britain a valuable lesson with regard to neglect of cultivation, which she is not likely to forget. There, the grasslands have constituted 69 per cent. of the total area of arable land as compared with Germany's 32 per cent., while the tons of corn raised per 100 acres have been given as 15 and 33 respectively. We know that but a small percentage of the soil of South Africa is arable, and that only a fraction of that has yet been developed. We produce 40 per cent. of our wheat requirements, and are already large exporters of maize, so that the possibilities of South Africa, as a cereal producing country, may to some extent be realised. It is a hopeful sign that farmers are beginning to venture further in new directions; fruit growing, especially that of citrus fruits, is developing rapidly, and a successful beginning has been made with cotton growing in the Transvaal. In 1916 seed was purchased, mainly from the Department of Agriculture, for 2,000 acres, and a yield of 100,000 to 150,000 pounds of cotton obtained. During the past season seed for 6,000 acres was sold, and when one thinks of the bye-products in the form of cotton-seed oil and fertilisers, it is clearly seen how important such an industry as cotton growing may become. In South Africa the Government is expected to do everything; so the cotton growers recently approached the Department of Mines and Industries with a view to Government assistance being given for the establishment centrally of the necessary mechanical plant. Whether the Government should be expected to assist directly in this way is a moot point; at any rate, the cotton growers were referred to the Land Bank with a view to obtaining a loan on co-operative lines. But the work which the Government is now doing—obtaining co-ordinated information—is clearly a Governmental duty, which, it is to be hoped, it will continue to do.

While the war has had the effect of stimulating, and in some cases initiating, production, it has also served to draw attention to products hitherto neglected, which could be used as substitutes. But think how little has been done to manufacture the valuable products from maize—alcohol, starch, glucose, dextrine, glycerine, corn oil, etc., apart from the valuable feeding stuffs and other bye-products obtained from these industries. At the last annual meeting of the S.A. Maize Growers' Association the President complained that practically nothing had been done to develop maize products in this country, and urged the appointment of a whole-time officer of the Agricultural Department to devote his energies to the maize growing industry and its many products. A new future is opened up for the maize grower by the possibility of the extended use of alcohol for power purposes. An investigation carried out two years ago demonstrated the practicability of alcohol as a motor fuel, so that now it is entirely a matter of commercial manufacture. In America the greater part of the industrial alcohol produced is made from maize. A factory, costing over £50,000, is in course of completion at Durban to produce alcohol from molasses, a

bye-product in sugar manufacture, but, as that is limited in amount, recourse must be had at no distant date to maize or other cereals, potatoes, etc. The agrimotor, of which hundreds are now at work day and night in Great Britain and France, is a product of the war, and with cheap alcohol motor fuel, derived from maize which he himself grows, to drive his mechanical cultivators, who shall say that the lot of the farmer of the future will not be a happy one? It will be seen that the subject of maize—its products and bye-products—is receiving the attention of the Scientific and Technical Committee.

There is abundant evidence that the country realises the need of a more forward policy with regard to the development of agriculture and its allied industries. A deputation from the South African National Union—an organisation which is doing good work in encouraging the use of South African products—recently waited upon the Minister of Agriculture and indicated the following as the directions in which action was necessary to stimulate productive expansion: the bringing of all sections of the agricultural population in closer touch with the Department of Agriculture; more roads, railways and bridges; provision for the collection of produce in areas situated at a distance from the railways; mechanical cultivation by means of cheap power; and a greater yield per acre. In striving after a greater yield per acre we are confronted with many of the important questions of the day: closer land settlement and greater co-operation amongst the farmers, water conservation, irrigation, afforestation, soil erosion, and the production and use of fertilisers.

On closer land settlement hinge many South African problems; in its train it brings increased employment, increased production, and, as a consequence, greater industrial expansion; while it is regarded as one of the favourite remedial measures for the "poor white" problem. The Government has admitted that land settlement schemes in the past have not proved the success anticipated. Failure has been attributed to the unsuitability and lack of enterprise and energy on the part of the settler, and to the unsuitability of the soil. The problem is admittedly a very difficult one, accentuated by the usual lack of capital on the part of the settler; but difficulties have been experienced in the initial stages in other countries, which have now successful settlement schemes. Land settlement and irrigation schemes are expensive undertakings, but the bold and welcome progressive policy which has been decided upon must redound to the national good in the long run. In addition to total commitments of nearly one and three quarter millions, previously approved, new commitments of close on one million sterling have been accepted during the present session for irrigation projects.

We also want a vigorous afforestation policy. Timber is used as a material in practically every industry, and its increasing use has for some years caused no little anxiety as to the

world's supply; certain varieties are even now practically unobtainable. Attention is, therefore, being frequently drawn to the value of afforestation as a State asset. But afforestation is of national importance, apart from the value of the timber produced. It has served for some years as a means of alleviating the poor white problem. It is a potent agent in the conservation of water, which is of all the more importance in a country like South Africa, so subject to periods of drought, and where soil erosion is becoming a national problem. All over the country we can see large areas absolutely ruined by a network of huge dongas, developed from small sluits, which originated probably in a cattle track. The Railway Department has been blamed, so have the Government road contractors, the Irrigation Department has been accused of negligence, while the older inhabitants blame the Government and say that soil erosion is entirely due to the denudation of trees and vegetation without a policy of replacement. The Minister of Lands blames the farmers! He has said that the first step towards a remedy is " to rouse public opinion and get the agriculturist interested in the matter." The remedies are said to include filling up the small sluits when they begin to form; increased afforestation and grass planting, which assists in conserving the rainfall instead of allowing it to carry millions of tons of valuable soil to the sea; and, of course, dam building and irrigation, which are claimed to herald the agricultural salvation of South Africa. The Government has repeatedly stated that it is alive to the importance of afforestation, and the Union can hardly be charged with negligence since 6,300 acres were afforested in 1914, and although the acreage fell for obvious reasons to 3,900 in 1915, and was slightly under 2,400 in 1916, to-day the total area of forest reserves under the Forestry Department is over 1,000,000 morgen. The State cannot be expected to do everything. Surely the farmer, who, in the majority of cases, is the landowner, realises that it is in his own interests, both from the water conservation and the other points of view, to prosecute a vigorous scheme of afforestation, and, much as the State might assist in fighting soil erosion, individual effort must be strenuously exerted, if the problem is going to be solved.

These are subjects, which I am glad to say, are receiving the attention of the Scientific and Technical Committee.

The first work of this Committee has been to arrange for a survey of the raw materials of the country, so as to ascertain what is available for active industrial exploitation. The Government is paving the way by investigation and research to shew the world what the prospects of industry are, but the Minister of Mines and Industries has said that "the Government can only see that general conditions as regards tariff and legislation are reasonable and representative."

It is claimed that a country which imports annually thirty-eight million pounds worth of merchandise must have great

manufacturing possibilities. But manufacturing industries have languished in South Africa, and industrial failures have been many, due to a variety of causes. As one writer plaintively remarks, there has been "the usual dissipation of energies; the usual record of a few successes and many failures; and the usual discouragement, which seems the natural inheritance of the few people who try to bring South Africa to a realisation of her unique opportunities."

Often enough the complaint is made that South Africa has neglected her opportunities; that she is only now beginning to investigate her resources as regards the adequacy and suitability of raw materials; that, as compared with the other members of the Commonwealth of Nations, she is only now emerging from the stage of academic discussion, and is not yet able to put forward co-ordinated schemes for industrial expansion and development, which can be expected to attract capital; and capital is wanted as in other countries. The history of manufacturing countries proves that the industrial system has been built up mainly by private enterprise, and we must look mainly to the individual and the corporation to supply this capital. But all young countries have had Government support in the form of protection or bounties; this may, however, be considered by some to be a political question, and will not be discussed further here.

The war has changed many conservative views, and reforms have been introduced, which not so very long ago would have been considered revolutionary. We have seen State control accepted ungrudgingly in many enterprises hitherto considered sacred to the capitalist, and we have also seen that an "industrial miracle" can be accomplished when capital and labour work in harmony under State control, and when the workers realise the dangers of extremes in the doctrine of restriction of output. It is therefore, perhaps, not too much to hope that our Government may take a share in opening up and developing certain specific new industries by arranging directly for the provision of capital. With the national resources known, every effort must be made to induce a flow of capital for industrial purposes. On this point the Minister of Mines and Industries has said: "Efforts in the past have undoubtedly been half-hearted, which was exemplified by the saying that one could get money for any speculative mining proposition, but it was hard to get for industrial undertakings."

No industry can be welcomed as a permanent industry which does not utilise the raw products of the country. In this connection the absence of a "primary" iron and steel industry is most keenly felt. All manufacturers using metal are dependent upon the imported article, and although machinery is now being manufactured in South Africa, especially on the Rand, to an extent hitherto considered impossible, this has largely been due to the protection offered by the war, and must necessarily be

transient. The importance of the establishment of an iron and steel industry in South Africa transcends that of every other industry; South Africa can never hope to become a machinery manufacturing country without it. We have the raw materials in coal and ore, but markets will have to be created to keep such an industry going continuously, as it must of necessity do. The Government can help by assisting in the initial stages, and it is to be feared that without some direct special assistance, the prospects are remote. But it can also help indirectly through the railways. A guarantee of Government contracts, at any rate in the initial stages, should surely induce a flow of capital for such an important national industry. A glance at the imports for 1916 shews that, during that year, iron and steel to the value of nearly one and a quarter millions sterling, and machinery to the value of two and one-eighth millions sterling, were imported into the Union.

How colossal an iron and steel industry may become is shewn by the fact that the output of the United States Steel Corporation reached in 1916 the huge total of nearly fifteen and a half million tons.

A successful experimental plant, constituting the first electric furnace in South Africa, was erected by the Chamber of Mines during the past year for making steel castings (shoes and dies) from scrap metal, and the manufacture of bar iron, etc., from scrap metal has been carried on for some years in the Transvaal. Such industries have been referred to as "bastard" industries; primary industries utilising the raw materials are essential. A start was made last month in electro-chemical industries, when a factory for the manufacture of carbide was inaugurated on the Rand; but electro-chemical industries in other parts of the world rely mainly upon cheap electricity derived from water power, and it is of the utmost importance in the industrial development of this country that the Government should spare no expense in having the water-power resources of South Africa immediately investigated.

The great mistake in South Africa has been to look too much to the mines. Just as the discovery of the diamond mines saved the Cape Colony from dire financial distress, so we have the President of the Transvaal Chamber of Mines saying, at the last annual meeting of that body, that "the prosperity, and, indeed, the whole fabric, of the Union is largely based on the mining industry." But the mineral wealth of the Transvaal will not last for ever—the gold mines are a diminishing asset. Transvaal dividends amounted in 1916 to over nine million pounds, but the Rand cannot go on indefinitely contributing over 50 per cent. of the total revenue of the Union. We have examples from history to shew that, where enlightened action has prevailed, the revenues derived from mineral wealth, instead of being utilised to lighten the burdens of the general taxpayer, have, to a liberal extent, been devoted to the general development

of the country, and the establishment of industries to take the place of the worked out mines, including of necessity ample provision for education and technical training and research.

The results of the industrial census now being compiled will be awaited with much interest, since, for the first time, we shall be put in possession of the details of the industrial activities of the Union, apart from the already published statistics relating to power. The recent conference of manufacturers at Cape Town, described by the Minister of Mines and Industries as "the most important conference that had ever been held in South Africa," and at which a Chamber of Industries was formed, betokens an admirable spirit of co-operation. It is also a hopeful sign of the recognition of the importance of new industries that some of the larger towns in South Africa are offering special facilities for the acquisition of factory sites and power and water at cost price.

Every country is dependent to a greater or less extent on other countries for its raw materials, and we are all familiar with the efforts which are now being made to make the Empire self-supporting as regards raw materials for industries. South Africa must benefit by its inclusion in this scheme; for example, the world's principal source of chrome ore, so valuable in special steel making, is in Rhodesia, and the Prieska district is said to possess the largest deposits of asbestos in the world.

One of the saddest features of modern industrialism has been the cloud of suspicion and mistrust which has hung over the relationships between employer and employee. The frank and full recognition of trades unions by the mining employers of the Rand and the adoption of the principle of the "round table" conference, will, it is to be hoped, tend to the lasting benefit of both parties, and result in increased industrial efficiency to which nothing can contribute so much as a settled and contented community. To eliminate or even to minimise industrial warfare is a great achievement, which must add tremendously to the stability of industrial enterprises. But discipline and loyalty to their Unions is essential on the part of the workers if this new arrangement is going to bear the economic fruit anticipated.

This dissipation of the feeling of estrangement is one indication of the wider and deeper sympathies which are being engendered by the world crisis. As a prominent South African labour leader has said, the experiences through which so many millions are now passing "are going to produce a feeling of greater human sympathy between all men, which will enable them to achieve their end—the happiness of their fellow beings —with less rancour and bitterness."

The growing white population of this country makes agricultural and industrial development imperative, but greater attention must also be directed to the educational and technical equip-

ment of the youth. In his report for 1916, the Director of Education for the Transvaal says: "The need for a longer school life for all pupils, whatever their destination may be, has been urged on the ground that a higher standard of individual and national efficiency will in future be imperatively necessary. Post war problems and conditions are likely to impose a test severer than anything we have known before. There will be no room for slackers, and the daily output, whatever form it takes, will have to be improved in quality and increased in quantity. The productive power of the manhood and womanhood of the nation will have to be materially advanced, if we are to shoulder the burden which will be laid on us; and the necessary tuning up of the physical, mental and moral resources of the nation must be sought, in the first place, in longer and more effective training for all in the schools."

Compulsory education was instituted in the Transvaal in 1907, and, under the Ordinance passed in 1916, the Administrator has power, on the recommendation of a local authority, to raise the age or standard of exemption (at present Standard V, or 15 years) from compulsory attendance at school, and to provide for compulsory attendance at continuation classes. A minimum of two years after the completion of the sixth standard is contemplated by the Director, which means on the average eight years' schooling after the pupil has passed out of the sub-standards or grades. "We want," he says, "to keep these two years from fourteen to sixteen so pregnant with possibilities, for school for all pupils, and not see them given out to arresting and stunting labour or aimless loafing." The movement on the Rand is a strong one; let us all hope that it will meet with success. But it must be accompanied by reforms in the curricula, making them more vocational and specifically industrial. And the complete organisation beyond the primary school course, suggested by the Director, is—(1) general or high-school courses; (2) trades-school courses; (3) school-farm courses; (4) commercial courses; (5) domestic science courses; (6) urban technical courses; and (7) rural technical courses. The use of the word "technical" in this case is to be deprecated; such a school is proposed for Johannesburg, but what is meant is really a secondary school in which mathematics and science receive special attention. The trade school system in the Transvaal is now established on a firm basis; it receives the sympathy and whole-hearted support of the mine employers, and by a new arrangement, a two years' course at the Trades School has become the necessary preliminary to apprenticeship on the mines.

The mining industry continues to serve a useful purpose in allaying the hardships of unemployment. It may be of interest to note that about 46 per cent. of the total white employees on the mines are of South African birth; and the percentage of the white underground employees, who are South African born, cannot be less than 75 per cent. The establishment by the Govern-

ment, in conjunction with the Chamber of Mines, of Training Schools for Miners widens these avenues of employment, which, it is hoped, will be more and more taken advantage of. There are now over 70 pupils in attendance at the two schools already established; the intention is to arrange for six schools, accommodating 600 pupils. The course is a two year one, and the pupils can maintain themselves from the commencement. Much has been heard about the dread scourge of phthisis, but conditions have so vastly improved during the past few years that with miners properly trained in these schools to observe carefully precautions for health and safety, it is, perhaps, not too much to say that now mining on the Rand presents no greater dangers than many other occupations not usually considered dangerous.

The Minister of Mines has said: "In regard to Miners Phthisis, whereas in the past miners going down the mines always feared they would contract the disease, he was gratified to say that that state of affairs had practically disappeared altogether, and miners need no longer have any fear." For those occupying technical positions, the risk is, of course, very much less, and it is a source of regret that more South Africans do not qualify for the higher lucrative positions on the mines.

Reference must be made to the much-discussed "poor white" problem. It is one of the greatest and most difficult problems in South Africa, and as time goes on it grows in complexity. But it is of modern growth. Mr. Leslie, President of the Transvaal Municipal Association, who can speak with authority on this question, said last year: "Thirty years ago, when I was in this country, there were no poor and there were no rich; now there are numbers of rich men and thousands of poor people." Commissions have been appointed and congresses have been held to deal with this most baffling problem, and we must credit all political parties with a genuine desire to remove this danger to the State. In his illuminating report for 1916, the Director of Education for the Transvaal refers to "poor whites" who have been "unable to survive the stress and strain of economic competition." "This is a social difficulty everywhere," he says, "but it is intensified here by the presence of the native. It is lamentable enough under any circumstances that a section of the people should be helpless in the struggle for self-preservation; it is a national calamity, a canker in the social organism, when the sinking of that section coincides with the rising of the coloured races. That is the danger here. Various remedies have been put forward; repatriation, relief works, labour colonies and the like; and no doubt much can be done in the way of amelioration by such measures. All reformers, however, . . . have agreed that only by equipping the children of poor whites, through education, with the weapons of skill and intelligence, can eradication of the evil be hoped for. The skill and intelligence which will enable the children to succeed where their parents have failed, will not be developed by schooling limited

to the primary and rudimentary stages. They will need at least two additional years of vocational training. . . . They must be launched strong, alert, acquisitive and disciplined for work in the craft or calling they are to follow."

In view of this expression of opinion from such an authoritative quarter, it is exceedingly disappointing to find the Minister of Finance a few months ago admitting that "The history of the Provinces during the past few years had been the retardation, embarrassment and starvation of education . . ." although he added: "It is the first duty of Parliament to encourage education."

This starvation process also extends to the primary school teacher. It is gratifying to note that, in connection with the outstanding reforms in education, which are being introduced in the United Kingdom, the bulk of the three and a quarter million sterling increase in educational expenditure is being devoted to the increase of teachers' salaries.

The Administrator of the Cape Province stated at the beginning of this year, that there were 24,000 white children in the Cape Province not receiving school education. The corresponding number for the Transvaal is 6,000, or 6.8 per cent. of the European children of school age, while Natal is to be congratulated in having a percentage of only 1. The two chief difficulties given are distances and lack of accommodation. All authorities unite in declaring that this absence of school facilities is simply manufacturing "poor whites." At a Conference held at Krugersdorp, in January of this year, it was stated by a prominent minister of the Dutch Reformed Church that there were 80,000 poor whites in the Union, of whom 10,000 are the heads of families, the majority belonging to his denomination. Such an alarming position must be faced, and faced immediately and resolutely. The Cradock Conference, held last October, urged as remedies mainly labour colonies, more irrigation, more and more suitable education, and greater sympathy and co-operation on the part of the landowner farmers.

According to a statement by the Minister of Lands, land settlement operations have comprised since Union 3,900 settlers, and about four and a third million morgen of land, having a value of nearly two millions sterling, have been allotted, apart from 730 settlers who have been placed in closer settlements and in relief farms and labour colonies; further, in connection with the Government's land settlement schemes, over a million sterling has been advanced in irrigation loans, and £400,000 spent in irrigation works, while there are 205 farms at present available for settlement, which, together with new areas, provide sufficient land for some 2,000 settlers.

An unfortunate aspect is that many of the poor whites are practically unemployable, owing to want of education, absence of energy and indifference, the inevitable result of their misfortune,

and it is simply courting disaster to think of converting them into prosperous settlers; but it is our duty to try to save the younger generation.

The settlement of "poor whites" in connection with afforestation is in active operation at George and French Hoek, where provision has been made for 100 and 150 cottages respectively, the ultimate object being to provide for 400 families. In addition, 4,200 poor whites are reported to be working on the railways.

There is an observable tendency to regard every child as a State asset, and to devote more attention to its well-being. At the recent Conference at Capetown of the Child Welfare Committee, the Mayor of this town, Mr. Cluver, who presided, made an eloquent and forcible appeal to give children a better start in life. In the Transvaal the parent has been relieved of many parental functions. There we have free education and free books, and at the larger centres we have school clinics, free medical inspection, including free dentistry and spectacles when required, and free meals in necessitous cases. There the matter rests at present.

Reference may also be made to the Juvenile Advisory Boards, formed about two years ago in the various large towns of the Union to watch the career of the lads after leaving school, and in an advisory capacity assist them into useful employment. But those interested in this movement must realise that it is impossible for every boy leaving school to be converted into a skilled craftsman. A great proportion must spend their lives in unskilled, or rather semi-skilled work. Education, especially if made more practical and suitable, is of primary importance; but that alone will not solve the problem of the poor white and of unemployment. Greater opportunities of employment are essential; the mines, existing industries, land settlement, afforestation, etc., are not sufficient. South Africa now meets its own requirements in Portland cement; the position must be extended in all directions. A demand must be created for the "factory hand," and this is one of South Africa's greatest needs.

For the third time in succession the members of this Association meet in freedom and in comfort, notwithstanding the most terrible and devastating war which the world has ever known. Our good fortune is due, it is unnecessary for me to say, to our membership in the Great Commonweath of Nations. I will not attempt to deal with after-war problems, but may be permitted to quote the words of the British Premier in his speech at the Guildhall, three months ago: "When, after the war, reconstruction begins, I hope, trust and pray that we are not going to dive into the pigeon-holes of any party for dust-laden precedents or programmes. Let us think out the best methods for ourselves in face of the searching facts of which we knew nothing before the war. We are a thousand years older and wiser since the war. . . ." "And," he continued, "in no part of the sphere of statesmanship is there greater need for revised ideas

than in our attitudes towards the great Commonwealth of Nations known as the British Empire, which in the past we have treated as a glorious abstraction. . . . We have decided that in future it is the business of the British and Dominion statesman to knit the Empire with closer bonds and in the interest of trade, commerce, business and general intercourse."

And we echo the words of our King, the Honorary President of this Association, when he says:—

"The value of the Empire lies not in the greatness of its strength alone, but in the several contributions that each of its diverse parts, with varying circumstances and conditions, makes to one general stock of knowledge and progress."

Section A.—ASTRONOMY, MATHEMATICS, PHYSICS, METEOROLOGY, GEODESY, SURVEYING, ENGINEERING, ARCHITECTURE, AND GEOGRAPHY.

President of the Section—Prof. W. N. Roseveare, M.A.

MONDAY, JULY 2.

The President delivered the following address:—

Mathematical Analysis and Science.

We need not enter on a discussion of the meaning of "Science" generally—I will ask you to think rather in our every-day terms of "the Sciences." By a Science of any specified kind—Astronomy, Chemistry, Botany—we mean, I suppose, the systematic study of a group of facts and phenomena connected by some link of similarity. The aim of the system of study must be, as Mach says, "the completest possible presentment of facts *with the least possible expenditure of thought.*" The various Sciences, as we know them, seem to have a regular law of development: first, the bare collection of facts which present some likeness or common tendency; then, after the sifting out of extraneous matter, the cumulative evidence of this body of facts to some *laws*, some links of cause and effect, which distinguish one body of facts from others; next, the discovery and clear logical statement of the laws; and finally, the creation of a symbolic language by which these laws are expressed with the utmost brevity and economy of thought. By means of this specialized shorthand, effects can be prophesied from a given set of causes; the continued collection of facts (*i.e.*, making of experiments) serves to check the results, to suggest new ideas (needing new symbols), and to confirm or reject ideas arising, not from experience, but from suggestive grouping or development of the accepted symbols. To my mind, this Science language, in all its various forms, is mathematics; or, at least, it is the form into which mathematics has developed, and in which it will continue to develop. From this point of view mathematics is not a Science in itself, in so far as it does not originate in physical facts. All its attributes are those of language—the language in which the only verb form is "is equal to." Like other languages, it lends itself to literary development—to the use of words as words, of forms as forms: this may be regarded as its artistic side—*Pure* Mathematics. This development is often regarded by the eager Scientist as futile, as waste of ingenuity, yet, historically and logically, this artistic work is of the greatest service to the scientific branch; ingenious *a priori* combinations of symbols, worked out without any aim at ulterior representation of facts, have repeatedly been found useful and suggestive in scientific applications. Gill's tale of the voluminous pure mathematical author, Sylvester, who "thanked God he had

never written anything of any use to anyone," is well known to many here; on the other hand, it is generally accepted that mathematics coined for a special physical purpose are as a rule incomplete, and only find their full development in the hands of the detached pure mathematician untrammelled by the physical ideas which originated the symbolism.

Mathematics as the language of Science is also exempt from the limitations attaching to its humble origin from counting and elementary arithmetic. It is not limited to *quantitative* sentences; its symbols need not always represent numeral adjectives or ratios. In fact, arithmetic with its practical processes (that will not parse) is only a branch of the subject—a specialized interpretation of the symbols. The symbols may be used mathematically to connect any two ideas which can be said to be "equal" or "equivalent," to make any statement connecting cause and effect. From this point of view the main line of mathematics begins with the use of the unknown quantity, the solution of our friends the problems "think of a number," etc. I think it is arguable that the solution of any mathematical equation, whether algebraic or differential, depends on the reversion of simple processes—*e.g.,* subtraction, division, square root, integration. This general process may be well illustrated by the card trick in which the words one, two, three, etc., are spelt, a card being shifted from top to bottom at each letter, and the appropriate card thrown out at the end of each word. I believe this trick is usually done with 13 cards, which are previously arranged by the use of a mnemonic. To bring off the trick with the whole 52 cards of a pack seems difficult; but there is an easy way of arranging the pack by simply reversing the spelling operation and burying a card at the end of each word.

The first Science to complete the stages of evolution sketched at the beginning of this address was Mechanics, including Astronomy. Aristotle (384 B.C.), the accepted founder of "Science" in our civilization, suffered the inevitable fate of the pioneer: for want of accumulated facts and from a wish to produce results, he generalized too rapidly, so bequeathing to thinkers, in addition to his grand fundamental rules of experiment and classification of facts, a body of unscientific axioms which (as is the way with the dicta of a conspicuous genius in the hands of less capable posterity) became dogmas, and thereby clogged the wheels of Science, and concealed facts which we, with the glorious superiority of the inheritors of an accumulated estate, consider almost obvious. Such axioms were: "A heavy body falls faster than a light one," "Perfect motion is circular," "Nature is symmetrical." In a like manner, even Newton unconsciously kept English thinkers back for a century while continental mathematicians made great advances; and to-day, after two centuries, we are seeing new theories (which have already produced promising first-fruits) suggested by doubts of some of the foundations of the Newtonian philosophy:

these have to take the risk of heresy. We know that in Newton's case this binding down of posterity was against all his instincts. He claimed to confine himself exclusively to "*actual facts*"; he disliked and avoided "*hypotheses*": yet in "Corollaries to the great laws," on which have been built all our Exact Sciences, he dropped into unguarded statements on "absolute time" and "space" and "motion," which have, perhaps, hitherto kept us out of the very middle of the current of truth.

The Science of Mechanics is founded on the following events: *Copernicus,* a quiet monk from East Prussia (1473 to 1545), published arguments which very gradually convinced the thinking world that the Earth was a planet and moved round the Sun.

Kepler, of Wurtemberg (1571 to 1630), after a lifetime of guessing in twilight at the laws of motion of the planets, discovered that (contrary to all the accepted Aristotelian theories) the planets moved in ellipses with the Sun at one focus (not in circles) and obeyed two other laws.

Galileo (1564-1642), Professor of Mathematics at Pisa and Padua, in 1609 invented the telescope, and later the microscope. He had to face the Inquisition for his "heretical" views on the Earth's motion. (He was a devout Catholic: the heresy was not against Christianity, but against the prevailing Aristotelian philosophy). He had to retract; and, broken in health and later blind, he retired to Arcetri and worked out the laws of motion. He had used the famous leaning tower of Pisa to demonstrate that all bodies fall at the same rate, the resistance of the air explaining apparent anomalies; but the end of his life he devoted to the scientific formulation of the laws according to which motion takes place. It seems strange that such a task should be found undone at such a late date in civilization; but we must remember that printing only dates from 1455, that the Arabic notations in arithmetic was not established in Europe before 1300, and symbolical algebra not before 1600. Galileo's greatest feat consisted in grasping and enunciating the law of *inertia*—that the normal state of a free body is permanent motion in a straight line with uniform velocity. This was the generalized result of his proof by means of inclined planes that the velocity of a falling body is proportional to its time of falling, and that in consequence the distance fallen is proportional to the square of the time. He obtained this law with the help of an informal axiom that a body canot be made, by moving down and up inclined planes, to rise higher than its starting point.

Newton (not improbably "the finest intellect in history") was born in the year of Galileo's death (1642); he completed the work begun by Galileo by establishing the laws of motion in the form in which we know them to-day, and by them deduced from Kepler's astronomical data the true motion of the solar system and the law of gravitation. But between Galileo and him come two men to whom the Science of Mechanics owes much—

Descartes, of Brittany (1596-1650), and Huyghens, of the Hague (1629-1695). *Descartes* considered that one of the chief ends of philosophy was the complete mechanical explanation of nature: and he was sanguine of being able to achieve his end. He reasoned that all space must be occupied by matter imperceptible to the senses, but a necessary vehicle for force and light. In the absence of experimental data, he could only reach his ambition by generalizing on insufficient facts. If Newton's less ambitious but more accurate work had not within 50 years corrected Descarte's dreams, these might well have led Science astray. Yet Descartes' theories on a space dominated by systems of *vortices* were the foundation of the *æther* on which the chief modern developments have been built, and his happy introduction into geometry of *co-ordinates* for expressing algebraically the position of a point is essential to all accurate consideration of space relations. *Huyghens* was the author of the wave theory of light which Newton could not accept, but which is now fully established. Huygens also first perceived the principle of the Conservation of Energy, which has become a most powerful weapon for dealing mathematically with the mysteries of physics. This great principle, which has been (erroneously) quoted as a greater triumph than the law of gravitation itself, is a striking instance of the debt of physics to mathematics. Galileo obtained the two well-known equations connecting velocity, displacement and time ($v = ft$ and $s = \frac{1}{2}ft^2$). Now the elimination of t between these two equations is a step of the purest mathematics—a step quite independent of any physical meaning in the symbols. The result $v^2 = 2\,fs$ is born without a shred of physical meaning, and from it follows, by adding the idea of mass, the following general result: "The increase in the value of $\frac{1}{2}$ *mass.* $(vel)^2$ is equal to the product of a force into the distance through which it acts." Now this jumble of words has, to the non-mathematical mind, or to the uninitiated, no conceivable bearing on practical affairs. But we have a simple way of deceiving our non-mathematical critics, and gaining their support to our conclusions. We call a lump of symbols like "$\frac{1}{2}$ *mass.* $(vel)^2$" and "*force* $\times$ *distance*" by sweet-smelling words. Some genius proposed to call $\frac{1}{2}$ *mass.* $(vel)^2$ "energy," and *force* $\times$ *distance* "work done." Our equation then reads, "The gain of (kinetic) energy is equal to the work done (in any mechanical system)." Everyone now agrees that this is intelligible, especially if he realizes that "energy" means "the power of doing work." If words less fascinating than "energy" and "work," such as "logarithm," "momentum," "ergal," "entropy," had been coined, the plain man would have kept aloof; and his mildest criticism would have been, "You are talking in technical language: I cannot follow you." Now "energy" and "work" are as arbitrary translations of the symbols, and as technical, as any of those I have instanced. The "talking philosopher" has no more right to appropriate this "equation of energy" as a "world law" than the Binomial Theorem or other purely technical mathe-

matical result. The principle of the Conservation of Energy means nothing more nor less than the equation of which it is a happy translation: moreover, it establishes no reliable proposition outside systems which are known to obey the elementary laws of motion—*i.e.*, the domain of the mechanical sciences. The law seems often to be quoted by serious men as if it proved, "If you do enough thinking (logically or illogically), you will reach some valuable result;" "if you talk persistently enough you will get your way in the end." This question of words suggests that the use of "logarithms" would be much wider spread, and they would be much easier to learn, if they had been called what they are, "indices of ten." The choice of words makes, of course, little difference to the expert who has the idea safe: but the student and the public suffer much from unnecessary technicality. Of course, there is another point of view. If Galileo, in his tentative shots at the true laws of motion, had fixed his attention (as possibly Huyghens did) on the velocity acquired after a certain distance fallen, instead of after a certain time, he would have obtained "velocity varies as square root of distance," instead of "velocity varies as time," and our energy equation would not have appeared as secondary. But there is a wider view—that the entity which the historic development of the subject has hit on more or less accidentally, and which it has called "energy," is more "real," more fundamental, than the "mass" and "acceleration" by which we have approached it. Thus, the whole of dynamics in the case of one "degree of freedom" may be founded on what is, in the orthodox scheme, a derived proposition—viz., that in all motion a certain something, which we may as well call "energy" (including now both "kinetic" and "potential"), is constant. This simple statement does not suffice when there is more than one "degree of freedom": but the "energy" can in this case be made the foundation of the treatment necessary for the solution.

This use of energy represents, on the one hand, the modern development of the Newtonian philosophy, and on the other a certain desire to get beyond Newton. Newton's system has not succeeded in explaining all the phenomena; and recently the conviction has grown that something more—or different—is needed: a few accepted facts seem, after much patient work, to be irreconcilable with the principles of that system. I will venture to show shortly how Newton's scheme for two centuries succeeded in explaining phenomenon after phenomenon, until thinkers became confident that no new theory would be necessary—that the Newtonian laws would ultimately explain every fact in the universe. This confidence has only been shaken within the last 40 years; it has at last seemed possible to prove that one or two phenomena were distinctly contrary to those laws.

Isaac Newton (1642 to 1727), Professor of Mathematics at

Cambridge, took up Galileo's work and first developed the laws of motion, which he enunciated (in substance) as:—

1. (The law of inertia). A body moves in a straight line with constant velocity unless interfered with.
2. The "change of quantity of motion" (mass $\times$ velocity) varies as the "*force*" applied. [This law has been changed by later thinkers to "the *rate* of change . . . ."]
3. Action and reaction are equal and opposite.

In these simple laws was embodied much original thought: we have been educated on such lines that they seem to us straightforward and to a great extent obvious. But (i), the word "*mass*" connotes a new idea, which the human mind had not grasped before—this idea is entirely Newtonian. It implies that, apart from *weight* (which is an old idea—prehistoric), a body has a certain *invariable* property implied by the words "quantity of stuff" or "matter," which has primarily nothing to do with weight; the idea in Newton's mind seems to have been almost as crudely objective as this: that matter consists of units of stuff—"molecules," "atoms," if you will—which are indivisible; and bodies only differ from one another for motion purposes by consisting of different numbers of these units, so that "obviously" (dangerous word) each body has a "quantity of motion"—say, 1,000 units moving each with 5 units of velocity implying 5 oco times as much motion as one unit moving with unit velocity. Just as 1,000 subscribers of £5 each may be regarded as 5,000 unit subscribers, or 1,000 men putting in 5 hours' work = 5,000 hours' work. This idea has become a commonplace to our civilization; but it is not fundamentally above criticism—it is one point on which revolt is possible in the new era—as, for instance, when the development of thought on the all-pervading "æther" has led to the statement, "The mass of an electron must be regarded as wholly electric."

The second word and idea that attracts attention is "force." The second law can be regarded as a *definition* of the word "force"—*i.e.*, *force* is that aspect of the *cause* of motion which reveals itself in the amount of the deviation from uniform velocity in a straight line. We can quite well build up a complete system on this definition, resolving to ignore all the ideas attaching, before Newton's time, to the word *force*, ignoring our muscular sensations. In acquiring or in teaching the orthodox Science of Mechanics, and, I imagine also, in other Sciences, the process seems to consist largely of sifting out a great mass of preconceived ideas and choosing a mere thread of them as forming the true conception, the rest being expected to conform with this scheme or being rejected as illusions. Indeed, is not this the essence of the idea of "Science"? and is not the aim of mathematical treatment to get away from "common-sense" and the senses generally on to a more trustworthy plane of abstract, almost superhuman, reasoning? But in his third law and in the

all-important corollary to his second law—that forces are *independent*, do not *interfere* with one another when acting simultaneously—Newton seems to utilize our preconceptions of the word "force."

The third law, which means, in plain language, that "the influence experienced by A owing to the presence of B, is always equal in amount, and opposite in direction to that experienced by B, owing to the presence of A," contains more material for thought and even doubt than seems to be allowed for by the best commentators. Mach says that this law is redundant, and should be included tacitly in a definition of *mass* (which apparently he would found on an instinctive conception of *force*). This great assumption is at the foundation of all Newtonian reasoning, and is not, in the new schemes of Relativity and the Quantum Theory, to be kept inviolate. It is not true of personal emotions, as we know well. Is it inconceivable that the sun should "attract" the earth while the earth is passive towards the sun?

A third fundamental idea in the laws (and this is the side on which they are regarded as vulnerable by the priests of Relativity) is the tacit assumption of an absolute space and time in the background—an absolute framework of reference. The great second law, on which is founded the mass of analysis which has borne the fruit of all our mechanical knowledge—our astronomical basis of time and space, our engineering, our means of transport, our electricity of all kinds, all our machinery, and also our high explosives and half unsuspected powers of destruction—depends only on *relative* velocities; for most of these results the motion of the earth is of no account; and for all, the motion of the "universe" of heavenly bodies round us is negligible: but in the more intimate probing into nature—into the properties of æther, light, gravitation—men have come right up against this tacit assumption of an absolute frame of reference, a conceivable *origin* and *axes* of space and time; and some decision has to be made.

But to complete our analysis of the history of the Newtonian philosophy which, seldom though we realize it, represents much of our present-day intellectual environment; is the *æther*, we may say, of our accepted facts—

Newton, by what to-day seems the simplest possible sequence of a few propositions, deduced from his laws a complete explanation of the motion of the solar system. The riddle of the ages, which Kepler had focussed so neatly, Newton was able to answer in a few words—the sun attracts all the planets with a force varying as the *mass* of each planet, and inversely as the square of its distance; and the same is true of the planets and their moons.

Hence, without much difficulty, the generalized Law of Gravitation: "Every material particle in the universe attracts every other material particle with a force varying as their two masses and inversely as the square of their distance."

Why is this the great achievement of human thought? Because it has been found to be *true—i.e.,* every theoretical result obtained by logical deduction from it has "come off," has been confirmed by experiment: as the telescopes, the micrometers and the spectroscopes have increased in accuracy, every observation has been found to converge to the results prophesied by the Newtonian reasoning. The planet Neptune (undreamt of before) was found where theory, working on otherwise unaccounted-for motions of Uranus, said it should be. Halley's comet returned duly after 75 years, as theory prophesied it would: corrections in the time of its return in 1910 which allowed, by Newton's laws, for the delaying influences of Jupiter and other bodies, were confirmed by facts. Great bridges, dams, warships, railways, bicycles, motor-cars, electric cables, wireless telegraphy, and all the rest, have in practice done exactly what Newton's laws led us to expect. We can safely put our money on these laws. But there are exceptions. The elliptic orbit of Mercury changes its position with reference to the sun much more rapidly than theory leads us to expect; light, in passing through crystals, seems strangely indifferent to the earth's motion; and the phenomena of radiation and radio-activity are not in harmony with the scheme that our theory has established for æther-matter relations. Some reliable physicists have come to the conclusion that some or all of these exceptions are finally irreconcilable with Newtonian philosophy; others do not yet despair of reconciling them to the system; but the heterodox view is gaining ground.

In our reverence for our intellectual father Newton, we may as well recognize that he had luck. Descartes' system, or the Astrologers', or the Aristotelian, might have been right: but they were unfortunate in finding facts ultimately across their lines of development instead of parallel to them.

The history of mechanics since Newton and Leibnitz died may be practically summed up as the automatic working of the machinery of "the Calculus" on Newton's laws. Poisson, D'Alembert, Euler, Lagrange, Laplace, Legendle, Gauss, Young, Fresnel, Faraday, Stokes, Helmholtz, Thomson, Maxwell, and the rest of the host, have been as poets speaking the language of the calculus, and laying bare, not the passing passions and emotions of humanity, but the secrets of nature, the foundations of the universe.

One great name is absent from my list—that of Faraday. He deserves mention by himself. His experimental and intellectual work on electricity were marvellous, and give him rank as one of the very greatest physicists; but he had no leanings towards mathematics, and preferred thinking in "tubes and lines of force," which he visualized as filling his space, to the standard "potentials" and energy functions. A striking tribute to his powers has been recently paid by J. J. Thomson, who, able mathematician as he is, has chosen in some of his work to recur to Faraday's tube-of-force form of reasoning.

To mention one other fruitful idea contained in Newton's Corollaries to his Laws—the misnamed "parallelogram" of forces. This everyday principle of mechanics is an immediate deduction from the principle of the *independence* of forces acting simultaneously, and attempts to establish it on purely statical principles are unsatisfactory. We realize it nowadays as having its origin deeper even than the laws of force: it is the law of addition of "vectors"—that is, if AB, BC represent any two "directed" quantities—any two similar concepts involving only magnitude and direction in space—then the two combined (*added* in the simplest sense) are represented by the short-cut AC.

One word on the Calculus. Up to Newton's time, mathematical analysis, such as it was—*i.e.,* symbolical arithmetic and algebra—lacked an essential qualification for a language of Science: it was essentially discrete; *continuity* was inexpressible by means of it. It has been aptly suggested that the Greeks, subtle, powerful intellects as they were, expressed their clearest, most scientific reasoning wholly in geometry (leaving "analysis" to be devised by the Hindoos and Arabs), because of this lack of continuity in analytical language. They loved numbers on their own account, but as a separate subject of thought, unconnected with space and time. When Newton, with that characteristic reluctance of the highest minds to publicity, ultimately consented to give his ideas to the world, he chose to present it in the old Greek geometrical form, with all the beauty of a complete picture, as contrasted with the business-like methods of a tape machine. Yet it is supposed that he obtained his results more as we do now, by the use of Descartes' co-ordinates and the methods of the Calculus, which he himself invented. This preference of Newton's for geometrical presentation had a curious result. His disciples in England clung to his prejudice; and so, though possessing fine intellects like Maclaurin, had little influence on the progress of Science, while Lagrange, Laplace and Legendre, the great French trio, and Euler and Gauss, filled a whole century with masterpieces of effective reasoning on the applications of the Law of Gravitation to the solar system and the wider universe of matter.

The dominating idea of the Laws of Motion is "rate of change." No one following this reasoning can fail to feel the need of some simple symbolism to express this idea. Newton did it by placing a dot over the symbol that expressed the changing thing; but he seems to have used it only in a mechanical sense for change in *time*. Leibnitz, who invented the system independently, seems to have approached it mathematically and purely symbolically, with no special reference to time; he and his followers applied the idea to every mathematical expression in their vocabulary—to every conceivable *function,* as we say—and so built up a mass of results, which were essential when the mechanical reasoning took, as it must, the form of differential equations needing the inverse process for their solution.

It has been said that "Nature expresses herself in differen-

tial equations: the details of human experience supplies the constants."

The only details of the development of the Calculus which I will refer to in connection with Science are:—

(i.) The *Potential*.—A great many of the vectors (or directed quantities)—forces, velocities, etc.—that crop up so inevitably in mechanical problems, were noticed to have one striking quality—the three components in space were the rates of change in their directions of some mathematical expression or function; as the flow of heat in any direction depends on the change in the direction of the point of the sum of the mass of every element of the attracting body divided by its distance from the point. In general, the force exerted by any system in any direction is the "gradient" or rate of change in that direction of the potential energy. This quantity was happily named by Green (a self-educated Nottingham miller) in 1828 the "potential" of the system. In every branch of Science it is our most effective weapon of attack, and the equation $\frac{\delta^2 V}{\delta x^2} + \frac{\delta^2 V}{\delta y^2} + \frac{\delta^2 V}{\delta z^2} \quad - 4\pi\rho$, connecting this potential (V) with the density (ρ) of matter electricity or heat, seems often to sum up the position completely. This equation is due to Laplace and Poisson.

(ii.) There are three purely mathematical propositions known by the names of their discoverers, Stokes, Gauss, and Green. Stokes' connects the value of a quantity round any closed circuit with its value over any *cap* having the circuit for boundary. That of Gauss connects in the same way the values over a closed surface with the values throughout the interior, and Green's gives the value at any outside point in terms of the values on the surface and inside. These theorems make many experimental results of apparent complexity mere logical consequences of simpler facts. Though fairly complex in their origin, and far removed from the intuitions of common sense, they are practically properties of geometrical space.

One cannot omit among the debts of science to mathematics a theorem established by Fourier in connection with the theory of heat. From what is essentially nothing more than an identity in elementary trigonometry, Fourier evolved simply a formula, whose physical meaning is, that any oscillatory or periodic motion consists of a series of simple wave motions whose periods are the submultiples of the main period. In short, it extends the idea of "harmonics," so familiar to musicians, to all cases of periodic motion. The well-known principles of physical reasoning known as Conservation of Angular Momentum, Conservation of Energy, Principle of Least Action, D'Alembert's Principle, are only convenient summaries of Newton's Laws, each, as it were, a sort of railhead in which a host of results are summarized, and from which attacks on new problems can start with economy of time and thought. But,

on the other hand, they may sometimes be regarded as expressing physical truths which are more real and fundamental than the simple principles from which they have been formed.

I pass now to what I fear must be a very incomplete sketch of the new "principle of relativity," which is a theory of mechanics based on ideas not consistent with some of Newton's theory. We must first consider the growth of the modern conception of an "æther" filling all space. Galileo suspected, and tried to find, a finite velocity for light. Roemer (1644 to 1710), followed by Bradley (1692 to 1762), by observations on the eclipses of Jupiter's satellites, obtained a value accepted to-day after a long series of laboratory and astronomical experiments —186,000 miles a second, or 3.10^{10} cm. per second. Huyghens suggested the wave theory of light. Newton rejected this on the ground of two or three definite conflicts with experiment. He could not decide on any satisfactory theory, but suggested as possible a certain scheme of semi-material "corpuscles" shot out by the sun and by every other source of light. This corpuscular theory, backed by some accordance with Descartes' theory of a space plenum, was elaborated and stereotyped by Newton's disciples. The wave theory was ultimately established by the phenomena of "diffraction" and "interference" (the haziness of the edges of shadows—the corpuscular theory would require clean-cut shadow edges); and by 1800 Young's and Fresnel's work had convinced the scientific world that light was propagated by means of vibrations in the front of a spherical wave with the source as centre, the radius as the "ray," and the vibrations in the tangent plane; *colours* being vibrations of different period—the red (and heat) rays of long period, the blue, violet and chemical rays short: all analogous to the theory of sound, except that the vibrations must be *transverse* (at right angles) to the ray. This spherical wave was modified in a material medium into an ellipsoid. But this theory, while ultimately explaining completely such phenomena as reflection, refraction, polarization, diffraction, and dispersion, involved thinkers in a big difficulty—the conception of some medium which should convey such vibrations through space. The medium could not be fluid, because the vibrations were transverse, needing some kind of friction between adjacent portions. Much labour was spent on the study of the mathematics of solid and semi-solid elastic bodies which might satisfy the needs of the "æther."

A serious difficulty was the interaction of æther and matter: experiment clearly proved that the æther must penetrate matter; matter must in some way consist of stuff (presumably particles) differentiated in some permanent way from the æther foundation. Any such conception implies *discontinuity;* and the whole body of mechanical science, with its indubitably correct results, has been built up on the mathematics of continuity. The theory of electricity and magnetism, which had more slowly reached the stage of mathematical treat-

ment, was found to need this same æther as a vehicle of transmission. At length Clerk Maxwell (1831-1879), an exceptional mathematician and experimenter combined, finally summed up a mass of subtle work (of which Faraday's was chief) by proving that light consists of a combination of electrical and magnetic vibrations in the æther, the electric vibration being at right angles to the magnetic. To explain this state of affairs physically he had to devise an æther consisting of rotating tubes (sort of vortices) conveying the magnetic disturbance, surrounded by particles, which are displaced by the tubular rotations, and so give rise to electric currents, the resulting *strain* producing electrostatic phenomena. These conclusions rest on a set of fairly simple differential equations, which describe the electro-magnetic state of the æther.

Maxwell's model has not carried conviction, and has been variously modified by later thinkers, the last form being known as the electron theory, an electron being a minute something charged with electricity, sometimes bound up in the constitution of the atoms of matter, sometimes conveying its charges through matter* Lord Kelvin, whose mathematical and experimental genius threw light on every branch of physical science during his long and strenuous life (1824 to 1908), made many attempts at a "model" of the æther, and at the end of his life confessed to the unsatisfactory results of everyone's efforts, adding: "I fear the electro-magnetic theory does not help us much." However, more recently Hertz confirmed Maxwell's theory by effecting the reflection and refraction of electric and magnetic waves experimentally, and showed that these waves obey the laws of light in these respects, and in interference, and in other respects; so that to-day, though Maxwell's "model" is not considered to represent the actual state of the æther, his equations are accepted universally. But one question has continually eluded discovery: Does a moving body move relative to the æther, or does it carry the æther with it in its course? Every experiment which is expected to show motion of the earth, *e.g.*, relative to the æther, gives a *null* result; and yet theory seems to need such relative motion. Three crucial experiments will show the state of affairs, and will introduce the new Principle of Relativity:—

Exp. 1.—Arago (1818) deduced from theory that since the deviation of a ray of light by a prism depends on the ratio of the velocity of light in space to its velocity in the material of the prism, any motion of the prism ought to betray itself by a change of angle well within his powers of measurement. The experiment showed no change whatever. Arago concluded that the æther was dragged along by the earth. Fresnel showed that there was another interpretation of the null result, viz., the prism might carry the æther with it partially (so as to preserve the

*"An election may be treated dynamically as a rigid body; its motion of translation is electricity, and its rotatory motions are magnetism."

greater density of æther in its material). In definite figures this would require the velocity of light in the prism to be increased by $v\left(1-\frac{1}{\mu^2}\right)$ owing to the prism's velocity v in the direction of the light.

Exp. 2.—In 1851, Fizeau tested Fresnel's explanation in the following way. He passed part of a ray of light through one of two parallel tubes of water; then reflected it back through the other tube: another part of the ray was made to follow the opposite course. Interference effects were produced. He now gave the water in the tubes a velocity v, so as to be against the one part of the ray and with the other. He found a distinct change in the interference effects; and his measurements showed that the effect of the velocity v on the velocity of the light in water agreed exactly with Fresnel's theoretical result, $v\left(1-\frac{1}{\mu^2}\right)$.

This result of Fizeau's, with the discovery of the alteration of light by Bradley, seemed to point definitely to the theory of the æther *not* moving: matter must move *through it and it through matter,* freely.

Exp. 3.—But in 1887, Michelsen and (with refinements) Morley designed an experiment which should show the velocity of the earth relation to the æther to the second order of the small fraction $v/$(velocity of light) (Fizeau's would only work to the first order). By means of moving mirrors from which a ray of light is reflected, a velocity of the earth relative to the æther should betray itself in interference effects, if it is as great as one-tenth of the earth's velocity in its orbit. The result of the experiment was "*no trace* of any such effect"; and repetition of the experiment with modified apparatus and greater refinement in 1905 confirmed this result.

Thus the (unpalatable) fact of no relative motion of æther and earth seemed to be established. However, an alternative explanation was (as usual) forthcoming: an Irish physicist, Fitzgerald, pointed out that the null result might imply (not a stagnant æther but) a physical change in the apparatus due to the motion: a contraction in the ratio $\sqrt{(1-v^2/c^2)}$* in the direction of motion would do. The conditions of the experiment showed that this effect must be the same for all materials. In 1895, H. A. Lorentz, of Leyden (who, with our Larmor and Einstein of Leipzig, is in the forefront of modern discussions of æther and matter) hit independently on Fitzgerald's idea. He (and Larmor subsequently to second order effects) working on the electron theory, of which Maxwell's electro-magnetic equations are an accepted part, established the following results: (i.) If the equations are satisfied by one system of electric charges at rest in the æther, they are equally well satisfied by a second system of electric changes all moving with velocity v, pro-

* v = velocity of body. c = velocity of light.

vided that all distances in the direction of v are supposed to contract in the ratio $\sqrt{(1-v^2/c^2)}$. (ii) If this system at rest is a material body, the second or moving system is a body moving with velocity $(-v)$, whose bulk is that of the first body modified by the above contraction.

The logical conclusion is that if a body is (gradually) set in motion from rest in the æther, this "Fitzgerald contraction" will take place automatically. The Newtonian "rigid body" is not even approximately realized in nature, except when the velocities are very small compared with that of light.

Experiments by Lord Rayleigh and by Brace, to see whether such contraction caused, as would be expected, double refraction of rays of light, gave no trace of such effect. Therefore the contraction theory must assume other modifications to neutralize optical effects. Other experiments on electrical and mechanical lines also failed to give expected results of this contraction.

The problem became more and more involved.

At this stage Einstein suggested the "Principle of Relativity" as a new theory of motion explaining these accumulated difficulties.

In its first simple form it postulated as a new fundamental principle of physical reasoning that the velocity of light must be equal and constant in all directions (in free æther) when expressed by means of any of the infinite number of space and time frameworks between which Newton's laws and experiment have failed to distinguish. The main effect of this new view is to lead us to expect phenomena to be all *relative* to the observer: the path of the same ray of light may be accurately described by one observer as straight, by another (employing a different framework) as circular. "Simultaneous" occurrences at two places cannot be regarded as a simple conception; nor can the length of a material body; and, strangest result of all, *gravitation*, as *the* phenomenon which is independent of all physical conditions (except what we call *mass*), appears inevitably in the analysis as a mere attribute of space-time represented by the coefficients which specify the framework of the equations, and which vary with the system of co-ordinates used. Our old co-ordinates x, y, z, t of space and time become four independent co-ordinates on equal footing; and we work as for a four dimensional space.

The mathematical theory for the simple case of uniform velocity of the framework in a straight line was soon effected in beautiful form by Minkowski, who introduces two forms of "vectors" ("4-vector" and "6-vector"), the former corresponding to the projections of a "straight line" on the four axes, the latter to the projections of a "surface" on the six axial planes. All expressions that do not vary with a change of co-ordinates are expressible in one of these forms. Einstein's later developments have extended the Principle so that it postulates that *all laws of nature* (not the velocity of light only) must be "invariant" when the framework in 4-dimension space is

changed. It has been shown that all "conformal" transformations in Minkowski's four dimensional space-time leave the forms of the accepted electro-magnetic equations unchanged—*i.e.*, these equations take a Minkowski vector form.

At the end of 1915 Einstein completed his generalized "Relativity" work on the theory of gravitation. The old Newtonian equations are greatly modified by the introduction of factors involving the ratio v/c. "Mass" is no longer simple. There is "rest mass" and "motion mass." The mathematical work tends to be very complicated, being effected by the theory of *tensors* (generalized vectors).

Newton's simple results appear as a first approximation: fortunately, the effects of the next order of approximation on the main results of solar system work is infinitesimal, except in the one outstanding discrepancy—the acceleration of 43 seconds per century in the orbit of Mercury. The new theory accounts completely for this phenomenon, which has been inexplicable on the old theory. "Relativists" (who are treated now with much respect owing to their success in solving this and other hitherto "insoluble" problems) claim that their theory will do away with the theoretical necessity of an æther, and that "henceforth space and time will be reduced to mere shadows, and only a sort of union of the two will retain reality." The new light on things has been compared to the enlightenment of dwellers on a cloudy planet, from which the stars are invisible, by their reaching a conception of the *rotation* of their framework (the planet), hitherto unsuspected.

Einstein's results may be summarized thus: Gravitation appears in our mathematical work merely as conditioning the framework: hence the effect of a strong gravitational field is equivalent to a change of co-ordinates (polar for Cartesian, moving axes for fixed, etc.): hence in a strong gravitational field light will appear not to travel in a straight line; moreover, light vibrations will be affected; the spectrum will be shifted towards the red. These last two definite results can be tested by observations. No opportunity of a crucial test has yet presented itself; but at the next total eclipse (May 29, 1919) faint stars will be photographed near the sun; if Einstein is right these will seem to be displaced as much as 1.7″ from their usual positions owing to their proximity to the sun. Thus the eclipse will receive from physicists an attention even keener than usual; instead of interesting details as to the composition of the sun, the corona, the prominences, etc., the fate of a new intellectual theory, a philosophical push towards Truth, the most ambitious and promising since Newton, will be in the balance.

Section B.—CHEMISTRY, GEOLOGY, METALLURGY, MINERALOGY AND GEOGRAPHY.

President of the Section.—Prof. M. M. Rindl, Ing.D.

TUESDAY, JULY 3.

The President delivered the following address:—

Phytochemical Research.

The need for the chemical and physiological investigation of the toxic and medicinal indigenous plants of South Africa has been the subject of many papers and addresses during the last two decades. These publications, by the late Prof. MacOwan, by Dr. Juritz, Prof. Marloth, and others, so eloquently review the present position of the subject, and so ably marshal the arguments in favour of undertaking such work, that I can add nothing new. It might be well, however, to emphasise again the fact that many thousands of head of stock succumb annually in consequence of eating poisonous plants, and that in dozens of cases of poisoning or suspected poisoning by plants, malicious or unintentional, the Public Prosecutor either declines to take action, or the accused is acquitted for lack of evidence of the toxic nature of the plant or extract administered. Figures are, unfortunately, not available at all, or not sufficiently accessible to the public. If statistics were collected, and if the widest publicity were given through the medium of newspaper articles and lectures, public interest might be aroused and a public opinion created in connection with the question of scientific investigation. Much of our backwardness in the matter of scientific progress is due to the prevalent idea that research is only the hobby of a few cranks. The recent decision of the Government to afford official support and recognition to research, and to take steps to promote the industrial development of the country, again lends an enhanced interest to this problem, among many others, and I have selected this subject for my address because I feel that the time may now be opportune for making a few positive suggestions as to how it may be successfully tackled, and to point out the obstacles which beset the path of the investigator who is thrown entirely upon his own resources. Fortunately, much can be done with existing institutions, laboratories, etc.; an elaborate organisation, although desirable for the future, is not necessary to make a beginning.

Much of the work done hitherto has been carried out by the Imperial Institute. As the Dominions Royal Commission in its recent report recommends that the research functions of the Imperial Institute be limited to work for India, the Crown Colonies, and the Protectorates, and that the Dominions should concentrate on the development of their own research institutions, it becomes incumbent upon us to take over responsibility,

and that without delay. But even if the recommendations of the Commission are not given effect to, it should not be consistent with our national pride as South Africans to let others do the work and be content to reap the benefits. Moreover, even if we are prepared to send the material overseas, the difficulty arises that its constituents may undergo change in transit. Some plants which are injurious when fresh produce no deleterious effects when dried; *e.g.*, feeding experiments have shown that *Crotalaria burkeana*, the cause of stiff-sickness in cattle, produces the disease only when fed in the fresh state.

The first step is the co-ordination of effort of those who are actively interested in the problem. A considerable amount of work is being done, and has been done, by individual effort, but most of it is of an incomplete and unsystematic nature, and naturally so, for the work involves the co-operation of the botanist, the chemist, the medical man, the veterinary surgeon, the farmer and the student of native laws and customs. There are at least twenty men in the country whose names could be mentioned in connection with work done in different directions on the question of indigenous plants. For an individual without official status the problem of putting into effect some efficient scheme of co-operation involves insuperable difficulties. The necessary correspondence absorbs far too much time, and there is likely, moreover, to be a suspicion that he may want to exploit his collaborators for his own ends. Only a recognised body can properly arrange the distribution of the work, and be a guarantee that every collaborator gets his due share of the kudos.

A census of the work already accomplished and the work still to be done is a comparatively simple matter. Several comprehensive publications on the subject already exist, which I attach at the end of my paper. I have made a systematic extract of the majority of the stray references distributed through the different agricultural journals of the Provinces of the Union, and through other periodicals. The greater part of the work under this subhead would be the collecting and verifying of hitherto unpublished information. There are hundreds of Dutch and native remedies still unrecorded. The case of native medicines in particular offers a wide field for the collector. We have a fair amount of knowledge of the herbs used by the Zulus, thanks to the labours of the Rev. A. T. Bryant, and many of the plants used by the natives of the Eastern Province are incorporated in Andrew Smith's "South African Materia Medica," and the Annual Reports of Dr. Juritz, Senior Government Analyst of the Cape Colony. But nothing has, to my knowledge, been printed about the medicinal herbs used by the natives of Basutoland and of Rhodesia.*

Everybody doing research work in this country is sadly handicapped by the lack of reference literature. I have fre-

* After completing this paper I was informed that some notes on the medicinal plants of Basutoland, by Dr. E. P. Phillips, will shortly be published in the Annals of the South African Museum.

quently been obliged to defer the continuation of or abandon an investigation for lack of the relevant literature. There are, it is true, a large number of periodicals in the possession of different institutions and private individuals in the country, but to the individual worker they are, to all intents and purposes, inaccessible. Few people would care to entail the trouble and expense involved in sending a large number of big volumes about, often for the sake of a reference of a few lines. And few owners would care to part with such books of reference, which are often in constant use, for any length of time. I have made a compilation from a large number of phytochemical publications of the periodicals most frequently referred to, which I append. If funds are available for the purpose, those periodicals, dating back, if possible, to their inception, should be incorporated in a central library. I am discussing only the research in plant constituents. When the question of making provision for physico-chemical or mineralogical or technological research arises, the list will have to be augmented. To make these periodicals available for every research chemist a librarian would have to be appointed, with a chemical training and the necessary working knowledge of the principal European languages, whose duty it would be to make excerpts for all research workers desiring information on certain points. It may be argued that such a scheme, if carried through for all experimental sciences, will entail the necessity of appointing a large library staff. But the actual amount of work required for each science will, for many years to come, be so small that one man, provided he is properly qualified, can cope with several subjects. Even if such a scheme should be considered feasible, some considerable time must elapse before it can be realised. Until then I would suggest that a catalogue of all chemical reference literature in the possession of individuals be drawn up on the same lines as the existing catalogue of reference works in the Peninsula, issued by the South African Library, and that the owners be approached to furnish replies to enquiries in much the same way as should be done by the Central Library, if such is created. As no individual or institution is in possession of more than one or two periodicals, the amount of work thrown on them would not be excessive. In addition, a small retaining fee might be paid to some South African students studying any of the experimental sciences in Europe or America, in return for making such abstracts as may from time to time be required by research workers, or, better still, it might be made a condition attaching to all Government and University scholarships. With an equitable distribution of the work, very little would fall on the shoulders of each student.

I have heard some very severe criticisms on the quality and quantity of research work done in this country, but such criticism comes from countries where research work is regarded as one of the functions of educational establishments and of certain Government departments. The daily routine and office duties leave the Government analyst very little leisure, and the Pro-

fessor of Chemistry, who is expected to teach all the branches of his science, physical, organic, inorganic, and technological chemistry, and to deal practically single-handed with all classes from Intermediate to M.A., inclusive, and in addition take his share in the administrative work of the College, needs to be possessed of an unusual amount of energy if he is to do any research in the leisure time he may have after fulfilling his other duties. An occasional free hour or two sandwiched in between routine work or teaching duties is of very little value for productive research. Many of the operations are such that they require to be extended and supervised over many hours, and cannot be discontinued at a moment's notice. Moreover, work which is carried out piecemeal must lack continuity both in conception and execution. The equipment of many of the College and Government laboratories is such that they could easily be turned to good account in the prosecution of research work if the staffs could get some relief from the excessive amount of work at present imposed upon them, and provided that that relief is afforded in such a manner as to concentrate all the routine of teaching into several days, and leave one or more entirely free days per week for research.

The idea underlying the present University syllabus, that three years' systematic study of the stereotyped kind will produce a scientist, is fallacious, and the sooner we break with it the better. At present we produce students who are veritable encyclopædias of knowledge, but who have only a very meagre amount of manipulative skill, and practically no scientific initiative or originality. The latitude left to every professor under the new University scheme as regards his syllabus and methods of teaching will doubtless improve matters. But I feel that the necessity for the inclusion of a very small amount of experience in the methods of research in the B.A. syllabus should be officially recognised. I am not advocating anything so foolish as that a complete piece of original research should be expected or demanded; that is a matter for the degree of D.Sc. But there is a considerable amount of spadework attached to the investigation of every problem which could very well be carried out by undergraduates with considerable benefit to themselves and to the progress of the work. It is a conservative estimate to say that half the publications in every chemical periodical in Europe and America come from college or University laboratories. Very often the author is only the intellectual father of the paper, whilst the experimental work has been carried through by young assistants or students.

A minute has recently been issued by the Department of Mines and Industries in which an effort is made to enlist the sympathy and co-operation of all scientific workers in the Union in the problem of the organisation of research. But little inducement is held out to participators. I hope I do not raise a storm of indignation among my scientific friends for expressing materialistic views. To undertake research work without

ulterior motives is highly commendable, when problems of merely scientific interest are involved. But the majority of the problems which the Department has in view, and which will have to be solved when the new research scheme is inaugurated, are not purely academic, and are bound to be of material benefit; and it is only reasonable that the men who do the brain work should reap some of the benefit. Even the man who is animated only by the highest scientific ideals will scarcely consent to surrender the results of years of patient labour and thought for somebody else's immediate benefit, unless he be entirely devoid of all business knowledge. In the case of the Government analysts, it seems only reasonable that the successful participation in research work should bring with it prospects of more rapid promotion. That would again be a stimulus to work beyond office hours. Owners of private laboratories will see nothing attractive in the scheme. Only professors and lecturers will be able to enter whole-heartedly into the work, because to them publications of research work are, or should be, the best testimonials when applying for new posts. I have digressed somewhat from my immediate subject, but the question of specialised research along certain lines, and the general question of making provision for research, are indissolubly bound up.

To return again to the question of plant investigation: a complete examination may require anything up to 50 kg. of material. Several enthusiastic friends of mine have supplied me with sufficient quantities of *Arctopus echinatus*, *Monsonia ovata*, and *Bulbine alooides*. But in view of the difficulty of determining the most suitable season for collecting, of the need of avoiding different species of the same genus being gathered together, and of deciding which parts (roots or stems or leaves and branches) should be collected, it is imperative that the work should be carried out under the supervision of a competent botanist. I have, for example, a parcel of *Monsonia*, which reached me in a very dry and powdery state, and with regard to which I had considerable difficulty in deciding whether it was the species *ovata* or *biflora*. Only in that way can material be obtained, the identity of which is beyond doubt. There should, however, be no difficulty in making the necessary provision. If I am rightly informed, an officer of the Department of Agriculture is at present collecting material for feeding tests to be carried out at the Veterinary Research Laboratory at Onderstepoort; and a similar arrangement might be made for medicinal and poisonous herbs when need arises.

The majority of the apparatus required are of a special type, not likely to be found in the equipment of the ordinary chemical laboratory. For getting the material into a sufficiently fine state of subdivision, a bone or maize crusher answers well. The first treatment by continuous percolation with hot alcohol requires an extractor with a capacity of approximately 50 litres. In the case of materials which in the preliminary investigation are shown to contain alkaloids, a large conical percolator is

required. For the subsequent distillation in steam, a copper vessel of about two gallons' capacity is needed. The distillate and the residual aqueous liquid left in the distilling vessel have to be repeatedly extracted with various organic solvents, and for this purpose a mechanically-driven shaking machine must be used. Some of the apparatus can, of course, be improvised, but even so the purchase of the remainder is an item which cannot be easily met out of the ordinary grants available for the maintenance of college laboratories. In addition, many gallons of organic solvents, alcohol, ether, chloroform, petroleum ether, etc., are used in the numerous extraction processes. There are several research grants in existence, the money for which is supplied mainly by the Government. In order to deal efficiently with the problem under discussion, the number of these grants should be considerably increased. The administration of them should, however, be left, as hitherto, in the hands of the Royal Society of South Africa, or it might perhaps be entrusted to a Committee of the Associated Scientific Societies of the country.

A preliminary examination of a small quantity of material (say 50 grams), according to the modified Dragendorff or Stas Otto method, supplemented by micro-chemical tests on sections, often gives a valuable orientation as to the presence or absence of certain important constituents, such as alkaloids, glucosides, or bitter principles, and may even afford a clue as to their nature. It is impossible to lay down any general law applicable to the treatment of every plant. But, except in the case of plants proved in the preliminary investigation to contain an alkaloid, the following method will, in most cases, lead to results. The material is initially extracted by continuous percolation with hot alcohol, and, after the removal of the greater part of the solvent, the extract is subjected to distillation in steam. The distillate, containing essential oils and volatile acids (formic, acetic, propionic, benzoic), can in most cases be discarded. The aqueous liquid in the distillation flask is separated from the resin, and the two treated separately with different solvents or precipitants. The aqueous liquid is usually extracted with ether and amyl alcohol, occasionally also with chloroform, and is finally precipitated with basic lead acetate. The resin is extracted in turn with petroleum ether, ether, chloroform, ethyl acetate, and alcohol. Each of the extracts usually contain several substances in solution which, in the case of solvents immiscible with water, may be separated by shaking the extracts with aqueous solutions of ammonium carbonate, alkali carbonate, or hydrates. The substances so obtained can usually be purified by crystallization or distillation, or both, or if the substances are resinous, acid or alkaline, hydrolysis may result in the formation of crystalline products. Plants containing alkaloids may be subjected to a preliminary treatment with a very dilute alcoholic or aqueous solution of a very weak acid (tartaric), which will in most cases remove the alkaloid as a salt.

The original alcoholic extract will contain a very large number of substances, many of which are of no interest from a physiological point of view, such as carbohydrates, fats, oils and waxes, phytosterols and phytosterolins (phytosterol glucosides), free acids, esters, essential oils and colouring matters. Flavonol derivatives, such as kæmpferol and quercetin, anthraquinone derivatives, as chrysophanol and emodin, glucosides, alkaloids, bitter principles (amaroids), saponins, toxalbumins, as ricin and abrin, tannins and active resins, are usually the substances which impart toxic or medicinal properties to the plants. With the exception of a few groups which are always encountered at a certain stage of the extraction process, it is impossible to predict at which juncture each of these are likely to be isolated. Fats, hydrocarbons and free alcohols are always found in the petroleum ether extract of the original resin; essential oils are always obtained in the distillate of the steam distillation process. But the pharmacologically and physiologically interesting compounds may be extracted by any one of the solvents previously referred to. Saponins, for example, have been found in the aqueous liquid as well as in the resin. For this reason it is desirable in every case to carry out a complete investigation of the plant. An additional difficulty lies in the fact that a very large number, if not the majority, of the principles are resinous; and with our imperfect knowledge of the nature and composition of resins, and in the absence of general methods of treatment, the problem becomes one of extraordinary intricacy. Moreover, with the very large number of constituents in the original resin, with the many processes to which it is subjected and the inevitable losses in purification, the amount of material obtained at each stage is small, unless a very considerable weight of the plant material is employed initially. Often, by the time a substance is obtained in a pure homogenous state, the total quantity available is less than a gram, and it requires very careful and skilful manipulation to make so small an amount suffice for complete characterisation of an unknown compound, combustion, determination of melting-point or boiling-point, of molecular weight, optical rotation, acetyl or benzoyl derivatives, physiological tests, etc. A careful study of the literature on the chemistry of other plants of the same species is often an excellent guide as to how to proceed, or what to expect. For example, I identified daphnin in *Lasiosiphon polycephalus* (Januariesbosje), and the same glucoside has been found to occur in two European species of the same order (Thymelaceæ), *Daphne mezereum* and *Daphne alpina*.

Turning now to the physiological action of the plants, our kowledge, although more advanced than with regard to the chemistry of the constituents, is still sadly deficient. With regard to plants eaten by stock, a number have, of course, been known for a long time to be extremely poisonous, such as Slangkop, Cape and Transvaal tulp, giftblaar, etc., and there is no doubt about the symptoms and post-mortem lesions. But

with regard to a very large number of plants we had, until a few years back, no knowledge as to whether they were injurious or innocuous. The Division for Veterinary Research, together with the Division of Botany, have taken the matter in hand in connection with botanical investigations into gal-lamziekte, and have compiled a list of suspected plants, with which feeding and drenching tests were carried out. I understand that experiments are still in progress, and I have reason to believe that the Department for Veterinary Research would welcome the opportunity of carying out physiological tests with any pure substances isolated from plants known or reputed to be injurious to stock. With regard to plants, supposed to be of medicinal value, very little published information about authentic tests by medical men is available. Apart from buchu and aloes, which are, of course, official, I know only of the publication on *Monsonia*, the dysentery cure, and the occurrence in it of an oleo-resin, entericin.* And yet I am acquainted with several medical men who, on the strength of actual experience, have great faith in some of the native remedies. Possibly their disinclination to rush into print is due to fear of ostracism by their colleagues for venturing to deviate from orthodox methods and prescriptions.

In consequence of the cessation of Continental supplies of drugs of vegetable origin following on the outbreak of the present war, attention was directed to other sources of supply in the Dominions and Dependencies. As a profitable source of atropine, or rather the isomeric hyoscyamine, the *Datura stramonium* (stinkblaar) seems promising. The hyoscyamine content of *Hyoscyamus muticus* is higher, it is true, than that of *Datura stramonium*. But according to analyses carried out at the Imperial Institute† stramonium of South African origin is superior to that from India, Europe, and the Sudan. The report refers only to a small number of samples, and there is no evidence to show that these samples represent the best quality obtainable here. The different parts of this country are so different with regard to climate, soil, rainfall, and other essential conditions of plant growth that plants display considerable variations in their toxicity and the amount of active principles they contain. *Ornithogalum thyrsoides* (the chinkerinchee) is undoubtedly extremely poisonous in some districts, whilst in others it is reported to be innocuous, and can be fed to animals without evil effects. *Croton gratissimum*, growing in Zululand, is declared to be very poisonous, whilst in parts of South-West Africa it is apparently a useful fodder plant. Similarly a systematic search might reveal the fact that the hyoscyamine content of the stinkblaar in some parts of the country is much higher than that of the specimens reported on. Present prices are abnormal, and cannot be regarded as a criterion, but it seems

* Maberley, *Lancet*, **2** (1909), 1363.

† Bulletin of the Imperial Institute, **14** [1], 25.

quite feasible that with pre-war prices it might be a profitable proposition to cultivate stramonium. Moreover, by cultivation the yield might be considerably raised. The percentage of sugar in the sugar beet, for example, has, by careful selection and cultivation, been raised from 5 to between 16 and 20 per cent. Other European medicinal plants, the dandelion and the foxglove, grow here without requiring any particular care, and might be turned to profit. There are experiment stations and agricultural schools and colleges distributed over the whole of the country, and it would surely be a small matter to set aside small plots on each for the experimental cultivation of some of these medicinal herbs if a preliminary examination seems to hold out prospects of financial success. With regard to the two indigenous plants or plant products which have become officinal, aloes and buchu, steps are desirable to improve the methods of extraction and treatment. Aloe extract is still largely prepared by the primitive method originally employed by the natives, with the result that the quality is not uniform. With regard to buchu leaves also, more care is required in collecting, grading, and packing. Attempts have been made by shippers to mix the medicinally valueless buchu substitute *Empleurum serratulum* with true buchu (*Barosma betulina*, *B. serratifolia* and *B. crenulata*), with the result that the prices were prejudicially affected, and our business prestige on the overseas market was damaged. Carelessness in curing and packing, with the resultant loss of volatile oil, leads to the same results. The question of compulsory grading before shipping is an almost insignificant matter as far as medicinal plants are concerned, but with regard to other exports it is a matter of considerable importance, and it is for that reason that I consider myself justified in laying stress on it here. Many of our products fetch lower prices on the world's markets than do those from other Dominions, on account of the lack of uniformity of quality. A few extracts from the annual report of the Trades Commissioner will serve to substantiate my statement. Commenting on the quality and condition of buchu, he says: " In 1910 large quantities of spurious leaves were shipped as buchu." " Dealers here allege that the collectors of the leaves purposely include the stems and woody parts."* And again with reference to wattle bark: " In a few instances dealers complain of the want of knowledge of some shippers in grading, want of care in protecting the bark from the rain and the weather previous to shipment, with the result that some of the bark arrived here in a wet and deteriorated condition."†

He inserts a similar adverse criticism on the quality of mohair. To show the results achieved by careful grading, I quote the following remarks from his report: " South African maize has established a high reputation because of its good

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* Annual Report of the Trade Commissioner for the year ending December 31, 1911, p. 42.

† *Loc. cit.*, p. 32.

quality and its low percentage of moisture, and because it is carefully and impartially graded by the Government graders at the ports of shipment."* And again with regard to fruit: "The inspection of fruit at the Cape Town Docks has, however, done a great deal of good, inasmuch as it has deterred shippers from forwarding varieties unsuitable for this market, and fruit which is badly packed or out of condition."† If careful supervision at the port of shipment has done so much to enhance our business reputation as far as the fruit and maize trade are concerned, it seems desirable to extend such supervision to all other exports.

With regard to fodder plants, we depend largely upon the somewhat unscientific and empirical method of leaving it to the stock to determine what is wholesome and palatable in the way of indigenous plants. There are hundreds of wild-growing species of which we know very little more than their distribution and habitat. Of only a small portion do we know the nutritious value, and one would imagine that such knowledge would be of the utmost benefit to stock-farmers, particularly in the arid Karroo region, where stock is entirely dependent for its subsistence on these wild shrubs. The whole question of the food value of indigenous shrubs, the distinction between edible and poisonous species of the same genus (*Euphorbia*), the temporary protection and systematic cultivation, is so important that the suggestion has been put forward to establish an experiment station in the Karroo for the purpose.‡ The changes produced in fodder plants by drought, wilting and withering, have hitherto not received the attention they merit. Cyanogenesis in many well-known stock foods under certain climatic and telluric conditions is a well-known phenomenon, and has been observed in Kaffir corn, beans and linseed, and fatal effects have also been traced to the accumulation of potassium nitrate during rainless periods in stunted and partly withered Kaffir corn. Might not some of these observations in the case of well-known fodder materials be a clue as to where to look in the case of some of the mysterious and unaccountable stock diseases. If it is not prussic acid, it may be some other poison developed under conditions of drought. But mere speculation is valueless. Experimental data are required.

The suggestions which I have put forward for organising phytochemical research may be briefly put as follows:—

(1) The formation of a small Committee for the purpose of distributing the work, co-ordinating the results of different collaborators, of arranging for joint publications, etc.

(2) The establishment of a central reference library with a staff of student abstractors, and, as a temporary measure, the

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* *Loc. cit.*, p. 24.

† *Loc. cit.*, p. 54.

‡ R. Marloth: Presidential Address to the S.A.A.A.S., Kimberley, 1914. p. 8.

compilation of a catalogue of relevant literature available in the country.

(3) An increase of the number of research grants available.

(4) Such additions to the staffs of Government, University and college laboratories, and such rearrangement of the work and the time-tables as will give the officers in charge of these laboratories a greater amount of leisure for the purpose of undertaking research work.

In conclusion, let me summarise some of the results that might be expected from an investigation of our indigenous flora systematically and thoroughly carried out. There are hundreds of medicinal plants and herbs used in different parts of the country. The striking and manifold virtues credited to them are doubtless largely ascribable to ignorance, faith and superstition. I might mention, for example, the obstinate faith of many people in *Sutherlandia fructescens* as a cure for cancer. But two of our indigenous plants and plant-products have found a place in the Pharmacopœia, aloes and buchu. Why should there not be more in a flora with over 12,000 species of flowering plants? *Monsonia ovata* and *biflora* (the dysentery cures), *Bulbine alooides*, and others, have been tried by critical medical men with encouraging results. With regard to the financial aspect of the question, I might state that the value of the aloes and buchu alone exported from the Union in 1913 was approximately £40,000. With regard to poisonous herbs administered by native medicine-men, I beg to direct your attention to a summary of cases of poisoning and suspected poisoning by indigenous plants investigated in the Cape Government chemical laboratories from 1899 to 1913.* Of 65 cases noted, the majority of which were fatal, the result of the examination in no less than 30 cases was negative or indefinite, and only in 17 cases was the identity of the plant established, and in some of these cases with the reservation "possibly." In at least half the cases the culprit must have been acquitted, and was free to continue his nefarious practice. In the majority of cases of poisoning of stock by plants we don't even know the symptoms, much less an effective antidote, and in the absence of any definite knowledge the farmer will fly to an aperient, where a sedative may be necessary, and thereby aggravate the evil, or he will apply other empirical cures which would seem to be worse than the disease. As I have said before, there are no statistics for the whole Union or for any Province. But a few records taken from one of the *Transvaal Agricultural Journals* will convey some ideas as to the havoc wrought among cattle by such virulent poisons as giftblaar: "On the farm Buffelsdraai 48, Pretoria District, nine newly-imported cattle died within about 24 hours, undoubtedly from eating giftblaar. A week later 25 imported cattle died on the farm Rietfontein 1,844, near Nyl-

* "The Urgency of a Definite Forward Movement in the Study of the Active Principles of S.A. Plants," Appendix. C. F. Juritz, *S.A. Medical Record*, Nov., 1915.

stroom, Waterberg District, in about the same length of time and the same cause." Turning now to stock diseases produced by plants, I believe that the cumulative vegetable poison theory of lamziekte is still in favour, although very little experimental evidence has so far been adduced. But there are two cases where the connection between poisonous plants and stock diseases has been definitely established. Molteno cattle disease has been proved to be due to two alkaloids occurring in *Senecio latifolius*, and stiff sickness is produced by *Crotalaria burkeana*. I have no doubt that there may be a hitherto unsuspected connection between other stock diseases and plants. Feeding tests may establish such a connection, but even then the cure would be a purely empirical one unless the principle were isolated and examined. From that point of view the problem of plant investigation becomes a useful, I might almost say necessary, adjunct to the valuable work carried out by the Department of Veterinary Research. Time and again this question of plant investigation has been raised, but the appeal has always fallen on deaf ears. This time, in view of the action contemplated, and the steps already taken by the Government in the question of research, the prospects are far more encouraging. But let us see to it that the matter is not again allowed to sink into oblivion.

Appendix I.

Publications dealing with South African Poisonous and Medicinal Plants.

1. *Beitrage zur Kenntniss der chemischen Bestandtheile der Früchte von* Hyaenanche globosa *Lamb., Euphorbiaceae*, J. B. **Henkel**. Inaugural Dissertation: Jena. (1857).
2. *Florae Capensis Medicae Prodromus*. **Pappe**, 3rd ed. (1868).
3. *The Chemistry of South African Plants and Plant Products*. R. **Marloth**, Presid. Address to Cape Chemical Society (1913).
4. *A Contribution to South African Materia Medica*. A. **Smith**. 3rd ed. (1895).
5. *Das Kapland*. R. **Marloth**, Jena (1908).
6. *South African Poisonous Plants*. L. H. **Walsh**, Capetown (1909).
7. *Die Harzmäntel von Sarcocaulon*, **Schulz**. Inaugural Dissertation: Potsdam (1906).

8. Agricultural Journal of the Cape of Good Hope—

   Kaffir Beers, their nature and composition, C. F. **Juritz**, (1906) [Jan.].

   The Chemistry of some Vegetable Products of South Africa, R. **Marloth**, (1909) [June].

9. Agricultural Journal of the Union of South Africa—

   Preliminary Report on Botanical Investigations into Gal-Lamziekte, J. **Burtt-Davy**. 4 [1, 2, 3, 5].

10. AMERICAN JOURNAL OF PHARMACY—

Chemical Examination of Lippia Scaberrima (*"Beukess Boss"*), **Power** and **Tutin, 79** (1907) [Oct.].

Chemical Examination of Ipomoea Purpurea, **Power** and **Rogerson** (1908) [June].

Chemical Examination of the Root of Lasiosiphon Meissnerianus, **Rogerson**, (1911) [Feb.].

11. ANNALEN DER CHEMIE—

Analysis of the Oil of Osmitopsis asteriscoides, **von Gorup-Besanez, 89**, No. 214.

12. ANNALS OF THE NATAL GOVERNMENT MUSEUM—

Zulu Medicines and Medicine Men, Rev. A. T. **Bryant, 2**, (1909) [1].

13. ANNALS OF THE SOUTH AFRICAN MUSEUM—

Flora of the Leribe Plateau; with a discussion on the relationships of the floras of Basutoland, the Kalahari, and the South-Eastern Regions: E. P. **Phillips, 16**, (1917), in the press.

14. APOTHEKER-ZEITUNG—

Über die Aloe, **Tschirch**, (1901), No. 78.

15. ARCHIV FÜR EXPERIMENTELLE PATHOLOGIE UND PHARMAKOLOGIE—

Untersuchungen über Buphane disticha, **Lewin, 68**, (1912).

16. ARCHIV DER PHARMACIE—

Some of the Constituents of Catha edulis (bosjemans thee) **Beitter, 239**, (1901) [17].

17. BERICHTE DER PHARMACEUTISCHEN GESELLSCHAFT—

Some Constituents of the seeds of Hyaenanche globosa (wolven boontjes), **Peckolt, 15**, Nos. 183 and 225 (1905).

18. BULLETIN OF THE IMPERIAL INSTITUTE—

Examination of Chailletia cymosa **1** (1903).

Investigation of vegetable drugs and poisonous plants, **13** (1915).

South African drugs and poisonous plants, **14**, (1916) [1].

The Hyoscyamine content of Datura stramonium **14** (1916), [1], 25.

19. CHEMICAL NEWS—

Some of the Constituents of Physalis Peruviana (*Cape gooseberry*), **102**, 320.

20. JOURNAL OF THE AMERICAN CHEMICAL SOCIETY—

Chemical and Physiological Examination of the Fruit of Chailletia Toxicaria, **Power** and **Tutin**, **28**, (1906) [9].

21. JOURNAL OF THE CHEMICAL SOCIETY—

The Alkaloids of Senecio latifolius, **Watt**, (1909) [March].
The constituents of Withania somnifera, **Power** and **Salway** (1911), [March].
The Constituents of the bulb of Buphane disticha, **Tutin**, (1911) [June].
The Constituents of Cluytia similis, **Tutin** and **Clewer**, (1912), [Nov.].
The Identification of Ipuranol and some Allied Compounds as Phytosterol Glucosides, **Power** and **Salway**, (1913) [March].
The Volatile Oil from the Leaves of Barosma venusta, **Goulding** and **Roberts**, (1914), [Nov.].
The Constituents of Rumex Ecklonianus, **Tutin** and **Clewer**, **97**, (1910) [1].
The Volatile Oil from the Tubers of Kaempferia ethelae, **Goulding** and **Roberts**, (1915) [March].

22. JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY—

Composition of the Fruit and Seeds of Adansonia digitata (*Baobab*), **Pelly**, (1913) [Aug.].

23. LANCET—

Some of the Constituents of Monsonia ovata, J. **Maberley**, (1909) [3] 1363.

24. MERCKS BERICHTE—

The Constituents of Leucadendron concinnum, (1895).

25. PHARMACEUTICAL JOURNAL—

Cape Bush Tea (Cyclopia Vogelii), **Greenish**, **11**, (1881) [Jan.].
Erythrnia Zeyheri, **Holmes**, **84**, (1910).
On Catha edulis, **Stockman**, **88**, (1912), [676].
Chemical Examination of Dicoma anomala, **Tutin** and **Naunton**, **90**, (1913) [694].
The Ethereal Oil of Barosma venusta, **Tutin** and **Jensen**, **89**, (1913).
Chemical Examination of Ornithogalum thyrsoides, **Power** and **Rogerson**, (1910) [March].

26. REPORTS OF THE SENIOR ANALYST (CAPE OF GOOD HOPE)—

Trichilia Dregei (1899).
Rauwolfia natalensis (*quinine tree*) (1901).
Acokanthera venenata (1902).
Buphane disticha (1903).
Clivia nobilis (1904).
Polygonum tomentosum *var.* glabrum (1904).
Haemanthus natalensis (1905).
Xanthoxylum capense (*wild cardamon*) (1906).
Helichrysum *sp.* (1908).
Haemanthus puniceus (1909).
Dimorphotheca *sp.* (*bietouw*) (1910).
Aster hispidus (Diplopappus asper) (1910).
Bowiea volubilis (1910).
Melia azedarach (*syringa*) (1910).
Knowltonia bracteata (1910).

27. REPORTS OF THE ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—

Notes on Crotalaria Burkeana *and other Leguminous Plants causing Disease in Stock,* J. **Burtt-Davy**, (1910), 269.
Poisonous Properties of Mesembrianthemum Mahoni, J. **Burtt-Davy** (1912), 193.
South African Plant Poisons and their Investigation, C. F. **Juritz**, (1914), 109.
Native Medicines, Rev. J. A. **Winter**, (1914), 404.
Notes on the Chemistry of the !Naras (Acanthosicyos horrida *Hook*). W. **Versfeld** and G. F. **Britten** (1915), 232.
Some Notes on Rhodesian Native Poisons, Rev. S. S. **Dornan**, (1916).

28. SOUTH AFRICAN MEDICAL RECORD—

The Urgency of a Definite Forward Movement in the Study of the Active Principles of South African Plants, C. F. **Juritz**, (1915) [Nov.].

29. TRANSACTIONS OF THE ROYAL SOCIETY—

Cyanogenesis in Plants, **Dunstan** and **Henry**, (1902), Series A, 399.
The Nature and Origin of the Poison of Lotus arabicus, **Dunstan** and **Henry**, (1901), Series B, 515.

30. TRANSACTIONS OF THE SOUTH AFRICAN PHILOSOPHICAL SOCIETY—

The "!Naras," Acanthosicyos horrida, *Hook.* R. **Marloth, 5,** (1886) [2], 229.

On some Experiments with the Active Principle of Mesembrianthemum tortuosum *L.** I. Meiring, 9, (1896) [1], 48.

Some Notes regarding South African Pharmacology, C. F. **Juritz, 16,** (1905) [2], 111.

31. TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTH AFRICA—

Note on the Occurrence of Daphnin in the Arthrosolen (Lasiosiphon polycephalus), M. **Rindl.** (in the press).

32. TRANSVAAL AGRICULTURAL JOURNAL—

On Dichapetalum cymosum, J. **Burtt-Davy, 8,** (1910), 626.

33. TROPENPFLANZER—

The Occurrence of an Alkaloid in Crotalaria Pechueliana (1902).

34. KAFFIR ENGLISH DICTIONARIES of **Kropf. McLaren,** and others.

APPENDIX II.

List of Periodicals most frequently quoted in Phytochemical Publications.

American Journal of Pharmacy.
Apotheker Zeitung.
Archiv für experimentelle Pathologie und Pharmakalogie.
Archiv der Pharmacie.
Berichte der deutschen chemischen Gesellschaft.
Bulletin of the Imperial Institute.
Bulletin de la Société Chimique de Paris.
Chemisches Centralblaat.
Comptes rendues de l'Académie des Sciences.
Journal of the American Chemical Society.
Journal of the Chemical Society.
Journal de Pharmacie et de Chimie.
Journal für Praktische Chemie.
Liebig's Annalen der Chemie.
Pharmaceutical Journal.
Pharmaceutische Zeitschrift für Russland.
Proceedings of the American Pharmaceutical Association.
Year-book of Pharmacy.

* Prof. Hartwich, of Zurich, has isolated an alkaloid, mesembrine, from this plant; not known where published.

Section C.—BACTERIOLOGY, BOTANY, ZOOLOGY, AGRICULTURE, FORESTRY, PHYSIOLOGY, HYGIENE AND SANITARY SCIENCE.

President of the Section: J. Burtt-Davy, F.L.S., F.R.G.S.

WEDNESDAY, JULY 4.

The President delivered the following address:—

PROPOSAL FOR AN ORGANIZED BOTANICAL SURVEY OF SOUTH AFRICA.*

Faced directly or indirectly with war conditions, civilized countries are surveying their industrial resources to see wherein they can use materials of local production to replace those formerly imported, but now obtainable only with difficulty if at all. To attain the desired end such surveys must necessarily cover the whole field, including agriculture, commerce, science, arts and manufactures, from the finished product back to the raw material, be it animal, vegetable or mineral.

The object of this paper is to call attention to the desirability of including a botanical survey in a general survey of the natural resources of the country, and to suggest ways and means for carrying it out under existing conditions.

While it is true that a large part of the raw material of commerce, of vegetable origin, is no longer obtained from the wild plants of field or forest, but from strains improved by selection or by cross-breeding, and carefully grown under cultivation, there is always the possibility of discovering new plants of economic value in a country which has not been well explored botanically. This is particularly the case with such articles as fodder plants for stock, fibre plants, dye and tan plants, oil seeds, medicinal plants, rubbers and timbers.

But a still more important and useful purpose of a botanical survey is the determination of the soil and climatic features of a locality from the character and distribution of its native vegetation. This branch of botanical science is of particular importance in new and thinly settled countries, and may be the means of saving the prospective settler from great financial loss, and in some cases even from ruin.

What other Countries are Doing.

The public recognition of the practical value of the survey of a country is not new. The Indian Government began such a survey of India many years ago, employing trained scientific

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* As originally presented to the meeting, the address referred to a *biological survey*. Owing to requirements of space the author decided to print only the main portion, which related to the botanical survey.

reporters, including an economic botanist, and issued a valuable series of reports, which were eventually compiled by Dr. George Watt into the well-known "Dictionary of the Economic Products of India." The Indian survey included a wide range of subjects from plants to minerals.

In the United States of America several of the States have carried out surveys of their natural resources. The Federal Government, also, has for many years maintained well organized and staffed geological, biological and soil surveys. Members of the staff of the U.S. Department of Agriculture have published a condensed review of agriculture in the United States in the form of a single volume, which is found of the greatest use as a book of reference in other parts of the world.

Even Japan, one of the youngest of civilized nations, has issued an account of the economic plants of her empire.

In Australia botanical surveys were carried out by the Governments of Victoria, New South Wales and Queensland, resulting in the publication of such useful works as Mueller's "Select Extra-tropical Plants," which embodied not only the economic plants of Victoria, but such as were known (or considered likely) to be successful if introduced into cultivation. So valuable was this work considered that it passed through at least nine editions within the lifetime of its author. Mr. J. H. Maiden, F.R.S., of New South Wales, also prepared and published a valuable handbook called "The Useful Plants of Australia." These two books have had a world-wide circulation, and have led to the systematic introduction of Australian plants into cultivation in other countries, which have greatly benefited thereby. Australia herself also profited by the wide advertisement given to her products, as well as by the sale of seeds of her economic plants. The successful and profitable cultivation of the numerous species of Eucalyptus in California and South Africa, and of wattles in Natal, is directly traceable to these Australian Government surveys.

A survey such as I advocate for South Africa cannot be completed in a few months, even under more favourable conditions as regards men and means than exist to-day. It involves the patient, persistent work of several years and of many trained specialists. To ask Government to embark on a vast and expensive scheme under present conditions would be unwise, to say the least, and would certainly meet with refusal.

We have, however, a number of botanists on the staffs of the various educational institutions scattered through the Union, together with a few in Government service and a few in private life. Some of these men have volunteered their services for a botanical survey, and if others were also willing to take a share of the work, and if the scheme were properly organized so as to avoid overlapping and to cover the whole field, we should, with a little financial assistance from Government, soon have some valuable information at our disposal.

Scope

In preparing the following paper I have had to remember that I am addressing not only botanists; my botanical friends must therefore pardon me if I have made some statements which are to them so obvious as to seem unnecessary.

Let us consider for a moment the ground which a botanical survey of the country should cover, with the two objects in view, (1) increase of knowledge, and (2) its practical application. The subject is so large that it is divided into several branches, each of which is usually dealt with by one or more specialists; these are:—

Taxonomy and Morphology.
Geographical Distribution or Floristic Plant Geography.
Ecology or Ecological Plant Geography.
Economic Botany.
Plant Pathology.
Physiology, Anatomy, Histology, and Cytology.
Genetics.

We will briefly consider these in detail.

Taxonomy.

Taxonomy or Systematic Botany deals with the relationships of plants, their naming and classification. Before we can catalogue and describe intelligently the uses of plants, their ecological and geographical distribution, their morphology, anatomy, histology, cytology or physiology, or, in fact, anything else about them, we must have names by which to refer to them intelligibly, and descriptions by which to identify them.

For this reason the collection and publication of descriptive accounts of the plants comprising a flora is the first step towards a knowledge of that flora. This essential work is, however, but a means to an end, though unfortunately sometimes mistaken for the end itself.

The preparation of a descriptive handbook or "Flora" follows, for the use of students and those investigating other branches of botanical science.

The Spermaphyta.

Much work has already been done in the collection and description of the elements of the native flora of South Africa. The original descriptions of the species are widely scattered through botanical literature, and the collection of them all in one library would involve a heavy expenditure of time and money; in fact, it would now be well-nigh impossible to secure all of them.

But we are indebted to the foresight of the Directors and staffs, past and present, of the Royal Botanic Gardens, Kew,*

* Although it was Prof. Harvey, of Dublin University, aided by Dr. Sonder, of Hamburg, who actually prepared the first three volumes of the "Flora Capensis," Harvey, "its principal author," states that it was Sir William Hooker, Director of Kew, who "suggested" the work, and

which, aided by small grants from the Governments of the Cape, Natal and the Transvaal, planned, organized and carried out the heavy task of gathering together all the available information on the flora of South Africa and published the same in the form of the "Flora Capensis." This work is but one of a series of Colonial Floras (including those of British India, Australia, Hong Kong, Mauritius and the Seychelles, New Zealand, Tropical Africa and South Africa), planned and carried out by Kew, with a truly broadminded and Imperial policy. It is instructive to note that the preparation and publication of that classical work, the "Genera Plantarum" of Bentham and Hooker, was undertaken as the first step toward the preparation of these Colonial Floras.

Lack of funds, and still more the lack of enough trained men on the Kew staff, has delayed the completion of the "Flora Capensis," but with dogged British pertinacity, in spite of delays, drawbacks and difficulties, Kew has persevered in this work until it is now near completion.

The "Flora Capensis" was commenced in 1860, and is only now nearing completion. Up to the time of publication of the third volume (1865) but little plant-collecting had been done in the interior of South Africa, and there was scarcely any material available from the Orange Free State or the Transvaal. The first three volumes are therefore almost entirely out of date, and are of comparatively little use to workers on the floras of these two Provinces. Volume VI, comprising the large and important families sometimes grouped under the name "Petaloid Monocotyledons," is also badly in need of revision before it can be of assistance to local workers. Not only so, but in every group of plants Transvaal botanists are constantly meeting with puzzling or undescribed species.

Though much has been accomplished, there is therefore still a great deal of spade work to be done before we can discuss our flora intelligently. The publication of a revised edition of the "Flora Capensis" has been suggested, but it is scarcely likely that this will be undertaken; apart from any question of cost, or of difficulty in getting the work done, the book would be so cumbersome and so expensive that it would not meet the needs of working botanists and students; owing to the price of such a large work, not enough copies would be sold to cover cost of publication, let alone cost of preparation; the work would be unnecessarily cumbersome, including descriptions of so many plants found in only one of the four Provinces of the Union. Our flora is too

"assisted in devising the plan on which it should be moulded; he also introduced the authors to many of the valued South African correspondents; and lastly, his strong recommendation of the undertaking to Sir George Grey was mainly instrumental in obtaining the grant from the Colonial Parliament." When Harvey died in 1866, "practically nothing available" relating to the succeeding volume was found among his papers; "nor did his coadjutor, Dr. Sonder, who died in 1881, undertake any further part in the work." It was Kew that gathered up the dropped threads, and has brought the work practically to completion.

large and too varied for even the Spermaphyta to be adequately treated in one comprehensive work.

A Series of Local Floras.

A better solution of the problem would be the preparation and publication of handbooks to the local floras, designed to cover approximate phyto-geographical regions rather than the political, but unnatural, Provincial areas.

The exact delimitation of the areas should be decided by a conference of local botanists, but as a basis for discussion I would suggest the following six regions:—

I. The South-Western Coast Region, from the Oliphants River to the Gamtoos River mouth, comprising mainly the region of winter rainfall.

II. The Karroo Region (the "Central Region" of the "Flora Capensis"), including the Cape Midlands north to the Orange River, and the Eastern Province from the Gamtoos to the Kei.

III. The Eastern Region, the coastal belt from the Kei River to Portuguese territory, and including the Transkeian Territories, Pondoland, Griqualand East, Natal and Zululand.

IV. The Transvaal Region, including the Transvaal, Orange Free State, Basutoland, Swaziland, Griqualand West and British Bechuanaland.

V. The Western Region from the tropic to the Oliphants River, including the South-West Protectorate and Great and Little Namaqualand.

VI. The Rhodesian Region, including Rhodesia, the Bechuanaland Protectorate and Nyassaland.

I will anticipate criticism by pointing out that the limits of these proposed Regional Floras do not necessarily coincide with the boundaries of our imperfectly understood phyto-geographical regions. We have to take into account the distribution of the white population, and the sale and use of our Floras in the schools. They do coincide pretty well with the regional classification adopted in the "Flora Capensis," as defined in the Preface to Volume VI; but I have naturally added Swaziland to the misnamed Kalahari Region, as its flora appears to me to be more nearly continuous with that of the North-Eastern Transvaal than with that of Natal and Zululand, from which it is cut off by the Lubombo Mountains. I have also, and I believe rightly, transferred to the Karroo Region that portion of the "Coast Region" of the "Flora Capensis" having a distinctly summer rainfall, and lying between the Gamtoos and Kei Rivers, containing, as it does, such a large element of Karroo flora among the Zwartkops, Sundays, and Fish Rivers; even if this should be open to question from the phyto-geographical point of view, it has an important practical bearing, inasmuch as it increases the utility and consequent selling value of the "Karroo Flora" (which could scarcely be supported by the sparse Karroo population) by including the

populous towns, watering places, and educational centres of East London, Port Elizabeth, Grahamstown, Kingwilliamstown and Uitenhage.

If these handbooks were issued at an early date, it would not be necessary to revise the volumes of the "Flora Capensis" above referred to, provided the authors had access to, or were able to consult by proxy, the collections at Kew and the British Museum.

A handbook to the flora of the Transvaal and adjacent territory (as included under the fourth head, above) is in course of preparation by the writer of this paper. A first instalment, in the form of a key to the families, is one of the papers offered at this session of the Association.

Mrs. Bolus and the staff of the Bolus Herbarium are at work on a Flora of the Cape Peninsula, and Miss Duthie on a Flora of the Stellenbosch District. These are only small portions of the interesting region of winter rainfall, but let us hope that these ladies will be willing, in the interests of science and the public, to extend the scope of their respective Floras.

In the preparation of these Regional Floras much time and space could be saved by reducing the descriptions of families and genera to the smallest limits compatible with clearness, leaving the longer and fuller descriptions for monographs and revisions, where they more properly belong. This could easily be done if we had an up-to-date "Genera of South African Plants"—a revised "Harvey's Genera"—to which the student could refer in case of doubt. Professor Moss, of the South African School of Mines and Technology, has given me permission to announce that he has taken this work in hand.

Check Lists.

The preparation of the Regional Floras would also be greatly facilitated and rendered more complete by the preliminary publication of "check-lists" for the several regions. These check-lists would assist in defining more exactly the limits of the several Floras, if they gave the known distribution of each species. I would also suggest that a reference be given to the place of publication of the original description.

Lists more or less answering to this description have already been prepared and published (or are in course of publication) as follows:—

Natal and Zululand, by Dr. J. Medley Wood, A.L.S.
Kaffraria, by T. R. Sim, F.L.S.
Cape Peninsula, by Dr. Bolus, F.L.S., and Major Wolley-Dod, F.L.S.
Transvaal and Swaziland, by J. Burtt-Davy, F.L.S., and Mrs. Pott.
Transkei, by Miss Pegler.
Mashonaland, by F. S. Eyles, F.L.S.
Gazaland, by W. Swynnerton, F.L.S.
Namaqualand, by the late Prof. Pearson, F.L.S.
Uitenhage and Port Elizabeth, by Prof Schönland, F.L.S.

We need such lists for the Orange Free State, Basutoland, the whole "Eastern Province" area, the Cape Midlands, British Bechuanaland, the Bechuanaland Protectorate and the S.W. Protectorate, and parts of Rhodesia, especially the vicinity of Bulawayo and the rest of Matabeleland.

It will be noted that none of the published Lists covers the entire area of any one of the six suggested Floral areas. When these have been defined by the suggested conference of botanists, one of the first steps might be to revise and extend them to cover the accepted areas.

The Sporophyta.

With reference to the less highly developed forms of plant-life, Mr. T. R. Sim has given us a second edition of his "Pteridophyta of South Africa," and is now engaged on a "Handbook to the Bryophyta." Professor Wager has recently published a check-list of the Mosses of South Africa.

Mr. Pole Evans and his staff in the Department of Agriculture, Pretoria, are at work on the mycology of South Africa, especially in its relation to plant pathology.

Miss Duthie is engaged on the Myxomycetes.

The late Dr. Becker made a large collection of our Marine Algæ, but we need a descriptive account of them, for the guidance of teachers and others interested in this attractive branch as well as for the use of those who would utilize the kelps for industrial purposes.

The Fresh-water Algæ, Characeæ, Lichenes, Diatomaceæ, and the Basidiomycetes and other groups of fungi, offer inviting fields of research for those who are training in botany in our universities and colleges.

Other Lines of Survey Work.

Although so much remains to be done on the taxonomic side, so much has already been accomplished that we are able to proceed with other lines of the survey without too serious hindrance from lack of names. When, in the course of our work we find an unnamed species of importance, we can—if unprepared to name it ourselves—submit it to one of the larger herbaria. Let us therefore consider, for a moment, the other directions which the survey should take.

The Economic Plant Survey.

The object of the Economic branch of the survey is to find out the relations of our flora to mankind; both the useful and the injurious properties of the species of which it is composed. The following are some of the more important questions which this branch of the survey is expected to answer:—

1. *Pasture Plants.*—Which of the native grasses and other plants are eaten by livestock? Where do they occur, and in what quantities? What is their relative feeding value? Which

are preferred by stock? Can they be cultivated artificially, and if so, how should they be treated?

2. *Poisonous Plants.*—Their distribution, composition, antidotes and method of eradication.

These plants are being investigated by the Veterinary Research Division of the Department of Agriculture, in collaboration with the Division of Plant Pathology and Botany.

3. *Noxious Weeds.*—Their occurrence, mode of distribution, eradication, and preventive measures to be taken against them. These are receiving attention at the hands of the Department of Agriculture at Pretoria.

4. *Medicinal Plants.*—Their distribution, relative abundance, properties, chemical composition, commercial value, and method of propagation. These have already received some attention from the late Rev. Andrew Smith, from Dr. Marloth, Dr. Juritz, Dr. Rindl and the late Prof. Pearson, and successful efforts are being made to propagate some of them at the National Botanic Garden, Kirstenbosch.

5. Insecticides.

6. Cereals, vegetables, fruits and other plant products suitable for human food.

7. Oil seeds (yielding fixed oils).

8. Essential oils and perfumes.

9. Gums, resins, waxes and rubbers.

10. Saponaceous plants.

11. Fibre plants.

12. Tan plants.

13. Dye plants.

14. Timber trees.

15. Basket and other wicker-work materials.

16. Plants of use as fertilizers (*i.e.,* suitable for green-manuring—nitrogen gatherers—or as sources of potash, lime, etc.).

17. Ornamental plants suitable for cultivation in gardens, or for export as dried flowers.

In all of these cases we need to know, in addition to the name of the plant and its relationships, its—

(*a*) Distribution.
(*b*) Relative abundance.
(*c*) Local uses and local names.
(*d*) Properties or composition.
(*e*) Commercial value.
(*f*) Methods of propagation and cultivation.
(*g*) Habitat.
(*h*) Any other facts about it likely to be of interest.

Farm, Garden, Orchard and Forest Crops.

An important part of the survey is the mapping of the country in relation to the crops already grown therein, and the possibility or desirability of extending those areas.

Supplementary to this, there should be prepared lists showing

—(*a*) those crops known to be unsuited to the country, with notes as to the reasons on which that conclusion is based; (*b*) crops not yet grown commercially, but considered worth trial, with notes on the localities considered most likely to suit their requirements.

Improvement by Breeding.

In connection with this branch, an important subject for report would be the possibilities of improvement by breeding of our wild plants of economic value. To this should be added a report on what has been done in other countries in the way of improving cultivated crops, and the bearing this may have on our own development.

The Ecological Survey.

Another and very important line of survey work already alluded to is that of the ecological distribution of our plants; that is to say, their relation to soil, temperature, rainfall, altitude, and other factors which affect their distribution.

From the purely scientific point of view we want to know precisely why, for instance, we find forests hanging to certain parts of the eastern slope of the Drakensberg, and not to other parts; why the upper levels of the great central plateau are so generally treeless, while the higher kopjes and hills often produce trees and shrubs, and the bushveld, 1,500 to 2,000 feet lower, is well covered with trees? Why do some plants grow only on saline ("brak") soils, some on limestone soils, and some on sands, while others prefer clays?

We find some plants growing in the shallowest soil, overlying rock, where they sometimes get practically no rain for four and even five months, and if given excessive moisture, they die; others, again, only grow where there is a constant and large supply of moisture, and some will only live in permanent water. On the other hand, we find some species of aquatic plants growing in ephemeral pools and "pans," and remaining dormant for five to seven months while the pools are dry; others, again, remain dormant while their roots are submerged for five to seven months, and produce foliage and flowers only when the mud is exposed and drying off.

While the desire for knowledge urges us to study the causes of facts, of which these are a few taken at random, the reasons governing them may have an important bearing on agricultural problems. The conditions under which a plant grows naturally, suggest methods of treatment to be applied to it and to plants of a like nature under cultivation. I do not mean to infer, however, that plants should not be cultivated under conditions different from those under which they grow in a wild state; we have many examples to prove the contrary. But the suggestions taken from nature, if properly interpreted, should be of assistance to the cultivator.

Ecology can be of great use in another way, especially in a new country. Carefully studied and correctly interpreted, the

native vegetation may be a valuable guide to the character of the soil from an agricultural and horticultural point of view. My old Professor of Agriculture, the late Professor Hilgard, was, I think, one of the first to apply this concept to agricultural practice, and I was engaged with him for some time in carrying out investigations on the relation of the vegetation to the alkali soils of California. The relation between a soil and its type of vegetation is especially marked in the case of brak soils, and this fact furnishes a valuable warning to the prospective settler as to soils to be avoided. On the South African High Veld the character of the grass becomes a guide to the character of the pasturage as regards "sweetness," which, again, in some districts at least, appears to depend on the character of the soil.

In certain parts of the country the presence of subterranean springs is indicated by the growth of a different type of vegetation; these moisture-indicators differ in different phytogeographical regions. Where the Vaal-bosch (*Tarchonanthus*) is a dominant feature of the vegetation, we may expect to find lime near the surface, sometimes in the form of a hardpan which renders the soil unsuitable for agriculture. Where the wild Seringa (*Burkea africana*) occurs, we learn to look for the Gift-blaar, *Dichapetalum cymosum*, so deadly to live-stock grazing in the springtime. Grass-veld, the vegetation of which contains a considerable admixture of plants other than Gramineæ, whether they be Cyperaceæ or Dicotyledoneæ, not only does not furnish so much grass as the typical grass-veld, but that which is present is often much less nutritious; it may be a paradise for the botanist seeking for species, but to the grazier it is "sour." Clay soils, black turfs, sandy soils, and quartzite and conglomerate soils each produce more or less distinctive types of vegetation which future investigation may prove to have value as soil indicators, especially where reconnaissances are being made for the selection of ranching country, or country suitable for closer settlement. In this connection it is well to note that appearances are often deceptive, and that the most densely grassed country does not necessarily afford the best or most nutritious grazing.

Rainfall.—So also with regard to rainfall. We know well how the succulent vegetation of the true Karroo differs from that of the Composite-Karroo, and that, again, from the flora of the Grass-Steppe. But even in the Grass-veld of the high plateau, we find a marked difference between the vegetation of the Machadodorp-Volksrust Zone with a rainfall of about 33 inches, and that of the Middelburg-Vereeniging Zone, with approximately 27 inches; the flora of this belt differs, again, from that of the belt lying west of Klerksdorp with 18 to 20 inches, while—going still farther west of the Kimberley-Mafeking railway—we get a different type again before we reach the true Kalahari. We know that the rainfall diminishes as we proceed westward from the Drakensberg (excepting perhaps on the high ridge of the Witwatersrand), forming rainfall belts

roughly parallel with the Drakensberg; the change of vegetation following this variation in rainfall needs to be carefully worked out in order to correlate it with zones of crop production. For instance, it would be useful to know precisely which rainfall average is the lowest safe limit for the production of Maize; we know this in a rough and ready way, but a more precise knowledge might save thousands of pounds to persons intending to take up farming in the neighbourhood of the border line.

Altitude.—Vegetation may in some cases be a good guide to altitude as it affects temperature and atmospheric moisture, if due allowance is made for the compensating effects of latitude, shelter from cold S.E. winds, etc. Thus the typical Bush-veld vegetation north of Pretoria does not appear to climb above approximately 3,800 feet; exceptions are found in the case of the sheltered North slope of the Magaliesberg, and of Meintjes Kopje, Pretoria, while a few typically Bush-veld species, such as *Chrysophyllum magalis-montanum* and *Landolphia capensis* occur at 5,700 feet on Houghton Ridge, Johannesburg, where the flora assumes a semi-Bush-veld facies.

Another interesting case is that of the grass *Andropogon ceresiæformis,* which appears to occur plentifully only above (approximately) 5,000 feet, although I have found small patches of it at about 4,900 feet, near Irene, and at Witkop on the Vereeniging line.

Other grasses, such as the larger Tambookie grasses (species of *Cymbopogon*) are characteristic of the lower Bush-veld at 1,500 to 2,000 feet, but whether this is due to climatic conditions associated with altitude, or to lack of adequate means of dispersal, needs investigation, for the advent of the railway on to the High-veld is resulting in the establishment of colonies of at least one species of Lowveld Tambookie at places like Breyten (5,880 feet), and above Pretoria (about 4,500 feet).

I merely mention these things in passing, as being apparent facts—suggestive of many others—which require more accurate investigation to determine how far our native plants may be used as guides to the character of the soil, moisture, climate (temperature and rainfall), and altitude, and in connection with these as crop indicators.

I have even heard old prospectors both here and in California claim that there are certain plants which indicate the occurrence of the rarer minerals (silver, gold and quicksilver) offering to point them out for a sum of money; but I have never spent anything on testing the theory

Geographical Distribution.

The geographical distribution of the component parts of our flora is a fascinating and important subject. More than one botanist has attempted to sketch the distribution of the flora of South Africa, but the most satisfactory attempt was that of the late Dr. Bolus in "Science in South Africa," prepared for the guidance of the British Association visitors in 1905.

Many systematists work out the geographical distribution of their plants in connection with the preparation of their Check-lists and Floras.

Dr. Phillips has been engaged in studying the distribution of the flora of the Basutoland Mountains, and is now working on that of the higher mountains of the Western Province.

Morphology, Physiology, Anatomy and Histology.

An instructive line of study is that of the relation between ecological factors and the form, structure and growth of plants. The importance of this subject has been so fully recognized by American botanists that they induced the Carnegie Institution to establish and maintain a laboratory in the great American Desert (at Tuczon, Arizona), for the special purpose of investigating these problems in relation to desert plants.

A useful piece of work from the point of view of both lecturer and student of botany would be the collection and publication of lists of native South African plants suitable for the illustration of various plant structures and adaptations—*e.g.*, xerophily, seed dispersal, types of leaf-form, etc.

A study of the anatomy of our native plants known or believed to be poisonous or of medicinal value is of great practical importance. At the present time many criminals, especially among natives, go unpunished because we are unable to identify the pieces of bark or root used by them with criminal intent. So also we are unable to identify roots of native plants used for medicinal purposes.

Co-Ordination of Existing Scientific Work.

To be successful and effective, scientific work must be carried out with a clear vision of the end to be attained. Unless there is a carefully mapped programme there will be much wasted effort, much repetition, much duplication of the work of others, all involving waste of time, and tending towards general inefficiency. There is so much to be done in a new country, and there are so few to do it, that duplication of effort should be reduced to the bare minimum by co-ordinating scientific work while leaving every worker free scope to exercise his individuality as regards detail.

In a thickly populated country, with a large number of well-educated and leisured people, there may not be the same objection to as many working on the same subject as may care to do so. But where workers are few and far between, there is no legitimate excuse. We cannot—and do not wish to—prevent the voluntary worker or the amateur scientist from taking up any line of investigation he may choose; but by presenting untouched fields to his vision he may be attracted into them. And under existing conditions Governments are not warranted in allowing institutions under their control unnecessarily to duplicate the work of one another, nor in allowing grants-in-aid to be

expended on duplication of work, unless such is specifically proved to be necessary. Having accepted this principle, how essential it is that Governments should see that it is carried into effect while existing war conditions prevail!

This applies to botanical just as much as to other scientific work. It is a great pity that there should be a number of institutions struggling along with inadequate equipment and support, each working on the same lines and endeavouring to cover the whole field of investigation in Systematic, Geographical, Ecological and other branches of botany, where each could accomplish so much more by concentrating on a single line of research.

At present I fear there is too much duplication of the work being carried on by existing institutions, colleges, museums and Government departments. It is as important from the point of view of efficiency and economy of public funds that a definite policy for a botanical survey should be laid down by agreement, and that the same be conscientiously adhered to by the institutions concerned, as it is to have a carefully defined policy for a geological survey, irrigation programme, or for agricultural investigation. In the past, when practically nothing had been done, collections were welcomed from every part of the country, and the chances of duplication were more remote. We have now reached a stage in our development when an organized botanical survey is called for, in order to take stock of our natural resources.

Means of Carrying out the Survey.

A botanical survey of South Africa could be carried out largely with the assistance of existing institutions, aided by small grants from Government for travel and other specific purposes, thus obviating, at least for the present, the necessity for a large Government staff engaged purely on survey work, which, however desirable it may seem to us, is wholly out of the question under existing conditions. My object to-day is to outline a workable scheme rather than an idealistic one.

The programme of such a survey should be broad enough to deal with all of the branches previously enumerated. Let us consider for a moment the treatment of each, as far as it concerns our survey; whether the plan here outlined could be carried out in its entirety would depend on the co-operation of the institutions and workers referred to.

Preparation of Regional Floras.

For the preparation of the suggested Regional Floras, good collections are required from all parts of the country. These specimens must be properly dried, pressed, classified, mounted and stored in herbaria accessible to workers. There should therefore be one good and well-equipped herbarium in each of the six areas for which it is proposed to prepare handbooks. Herbaria more or less representative of the local floras are in existence at Capetown, Stellenbosch, Grahamstown, Pretoria, and

Durban, and I am happy to be able to state that a beginning is being made at Johannesburg.

Regional Herbaria.

The work of the local herbaria could be rendered more effective if each restricted its investigations to the flora of the region in which it is situated, as defined by the proposed botanical conference. It means a great waste of energy for each herbarium to endeavour to make its collections completely representative of the whole of South Africa; every collection made outside an area means the expenditure of time and money which might be devoted to the increase of knowledge of its own region. So, also, where two herbaria already exist in the same town, as at Capetown and Pretoria, economy could be effected by a mutual agreement to avoid overlapping.

One of the functions of the Regional Herbaria should be the naming of specimens for collectors within the region controlled by that particular herbarium, including material submitted by Government departments; for this latter a specific subsidy might be asked from Government. By restricting the scope of the herbarium to the plants of a given area more room would, of course, be available for keeping a good series of specimens showing the distribution and variation of the species within the region, thus adding greatly to the value of the collection. Types of species found within the region should, as far as possible, be preserved in the Regional Herbarium.

A Central Herbarium.

In addition to the Regional Herbaria, there should be, for convenience of comparison or study, one herbarium containing as far as possible at least one typical representative of each species known to occur in South Africa. It should be the duty of this Central Herbarium to compare doubtful or critical material for the other herbaria. This Central Herbarium should also undertake to have its material critically compared with the types existing in European Herbaria, so that it might become the place of last resort—in South Africa—on questions of doubt.

One of the obvious functions of the National Botanic Garden at Kirstenbosch is to maintain such a National or Central Herbarium. The Bolus Herbarium, with its large number of critically compared specimens, would form an excellent nucleus for a central herbarium.

The Central Herbarium should, for some time to come, maintain a thoroughly qualified Systematist to compare critical material with the types and other authentic material at Kew and the British Museum, and to monograph the South African material deposited there, especially in those families dealt with in Volumes I, II, III and VI of the "Flora Capensis." He—or she— should be not merely a student working for a degree, but a

taxonomist of experience and mature judgment. The expense of maintaining such an officer should be borne out of the funds contributed by the Government towards the Botanical Survey.

Methods Suggested.

The survey which I have outlined covers a large field, but I am convinced that we cannot afford to face the problem with any less complete scheme. We must look at it not only in its relation to other surveys of our natural resources, but especially in the relation of its several parts to each other and to the whole. Unless we do this, our efforts will cease to be worthy the name of a survey.

It is essential that we bring to bear on our subject every available trained man, and all the equipment which the country possesses. We must co-ordinate our efforts. Let us see what are our available resources in this respect.

Men.—We have the Professors and their staffs at the University Colleges at Capetown, Stellenbosch, Wellington, Grahamstown, Bloemfontein, Maritzburg, Pretoria and Johannesburg; the Lecturers in Botany at the Government Schools of Agriculture, and the Staff of the Division of Plant Pathology and Botany of the Department of Agriculture. There are also a few independent workers, Dr. Marloth, Mr. T. R. Sim, Mr. E. E. Galpin, Mr. Flanagan, Miss Pegler, Mr. Swynnerton, the Ven. Archdeacon Rogers, Mr. Eyles, Mr. Frank Bolus, and the writer.

Herbaria.—We have several fairly good herbaria in South Africa—*e.g.*, the Bolus Herbarium at the S.A. College, Capetown; the Herbaria of the South African Museum, Capetown, and the Albany Museum, Grahamstown; the Natal Government Herbarium, Durban; the Transvaal Museum Herbarium, Pretoria; and the Herbarium of the Department of Agriculture, Pretoria, including the recently acquired Galpin Herbarium; a herbarium has also been started by Professor Moss at the S.A. School of Mines and Technology, Johannesburg.

Libraries.—Good botanical libraries are essential to the prosecution of botanical research. Reference libraries exist in connection with the Bolus Herbarium, the Albany Museum, and the Department of Agriculture, Pretoria, and smaller libraries in connection with the other herbaria, and it is hoped that Johannesburg will shortly be added to this list. Dr. Schönland has an excellent private library at Grahamstown, containing many volumes formerly belonging to the late Professor MacOwan. Owing to the cost and scarcity of botanical works, an effort should be made to develop one thoroughly good Central Botanical Library; the others might well be content with good working collections, provided arrangements were made for the loan of books and magazines from this Central Library, for stated periods. Arrangements should be made for the Central Library

to furnish carefully prepared and certified extracts from, and copies of original descriptions from, the rarer botanical works.

Co-ordination of Work.

With so many men and women, and so much equipment available, we certainly have the means at our disposal for carrying out a botanical survey on the lines I have indicated. I feel sure that we are all anxious to do our share, but we have been working alone, often overlapping one another, often wasting time for lack of the assistance that each might give the other if he or she knew that it was needed. Our efforts have been to some extent wasted because too individualistic, having no definite relation to a well-planned and well-organized scheme of botanical survey.

A Botanical Conference.

I have already suggested a Conference of botanists to discuss the phyto-geographical regions for the purpose of compilation of local Floras. This Conference should also consider the best means of conducting a botanical survey under existing circumstances. The Conference might well constitute itself a permanent Botanical Survey Advisory Council, with an Executive Committee authorized to approach the Government with a definite programme (as laid down by the Council), and an application for such funds as might be required to carry out its programme. Sub-committees should have charge of separate branches of the survey, and the Executive should consist of the Chairman, and the convener of each Sub-committee. The Council should be self-perpetuating, should elect its own Chairman yearly, and should frame its own rules and methods of procedure.

Each member of the Council should take up some part of the work, however small, as he or she is best able, and endeavour to carry it through on the lines laid down by the Conference.

The several branches of survey work should be subdivided, and the obviously fair way of distributing them would be with relation to the geographical position of the workers, somewhat as follows:—

Ecology.—This requires detailed work in each Province.

Western Province.—The Professor of Botany at the S.A. College, Capetown.

Eastern Province.—The Professor of Botany at the Rhodes University College.

Orange Free State.—The Professor of Botany at the Grey University College.

Natal.—The Professor of Botany at the Natal University College.

Transvaal.—Professor Moss, who has specialized in Ecology as well as in Taxonomy.

The work of these investigators would be co-ordinated by one of them, who would represent this branch of work on the Executive Committee.

Economic Botany.—This branch would be subdivided by subjects rather than by areas. Thus:—

Mycology and Plant Pathology are being dealt with by the several Mycologists of the Department of Agriculture.

Noxious Weeds, by the Herbarium Assistant of the same Department.

Poisonous Plants are being collected by a field botanist allocated to the staff of the Veterinary Research Laboratories. Feeding tests are being carried out by the Veterinary Research Officers, and the determinations are being made at the Herbarium of the Department of Agriculture. This applies to plants poisonous to stock. Probably the same officers could deal with plants poisonous to man, in conjunction with Dr. Rindl, of the Grey University College, but an addition to the staff would be required to study and classify the physical structure of the roots and twigs which form such an important part of the drugs used by kaffir witch-doctors and medicine-men. The assistance of a chemist should be secured to investigate their chemical properties.

A Handbook of the Economic Plants of South Africa is an urgently needed work at the present time. During the last fourteen years I have collected a mass of valuable data on the subject, which is now being put in book form.

Physiology of Farm Crops.—This subject would probably be dealt with at the several Government Schools of Agriculture.

Genetics and Plant Breeding would probably be taken up at the National Botanic Garden, and also by the Colleges or Departments of Agriculture of the several Universities.

TAXONOMY.

Check-Lists.—Each Provincial Institution should prepare a check-list of the plants known to exist within the borders assigned to it, with brief but complete notes on the distribution of the species within their limits, and reference to the place of publication, or of a good description, of the species.

Handbooks.—For the preparation of handbooks to the regional floras, it might be desirable to place this in the hands of one competent botanist, thus not only ensuring uniformity of treatment, but saving duplication of descriptions where the same genera or even species occur in more than one Province.

Handbook of the Genera.—A revision of the families and genera of South African Spermaphyta is much needed as a basis for the Regional Floras. This, as already noted, has been undertaken by Professor Moss.

Where so much ground has to be covered, and there is so much to be done, it is folly to delay matters by waiting till every rare species has been secured and every locality has been visited. The main object is to assist in the advancement of

science; for this purpose a handbook carefully and accurately prepared, if it covers most of the species of a flora, will be of great assistance, even though many of the rarer forms are omitted. To accomplish the best results in the shortest time, therefore, I would suggest the adoption of two courses: The collection of (1) the *dominant, sub-dominant,* and *social* members of the vegetation in the allotted territory; (2) fairly complete collections from selected localities which from their topography, soil or climate suggest a rich and varied flora. With regard to the first of these suggestions, I have found that a reconnaissance, or sort of flying survey, of the territory under review enables one to divide the region roughly into two or more distinct phyto-geographical areas. I have adopted the plan of taking one locality (for convenience a single registered farm of, say, approximately ten square miles in extent) and collecting, as far as possible, everything found growing upon it, including the cultivated plants. This gives surprisingly interesting results.

Geographical Distribution.

A branch of botanical survey work which has proved most fascinating has been the geographical distribution of species of plants. This is of value in connection with our study of plant ecology and phylogeny.

Although a good deal is now known of the floras of the Eastern and Western Regions, Natal, the Orange Free State and the Transvaal, there are large areas as yet almost unvisited. Thanks to the energy of the late Professor Pearson, a former President of this Section, we are now in possession of valuable data from the hitherto but little known though very interesting region of Namaqualand. But we know surprisingly little of the flora of the great Drakensberg Range; Basutoland is almost unknown; the same may be said of that huge tract of country from the Komatie River to the Limpopo, lying between the Drakensberg and the Lebombo Mountains, and particularly that great unsurveyed tract of Government land occupying the extreme north-east corner of the Transvaal; and the whole of the Limpopo drainage basin falls into the same category. Very little is known, either, of Zululand, the Transkei, and the western portion of the Kalahari. It may well be said that there is no portion of South Africa—unless perhaps it is the Cape Peninsula—of the flora of which we can claim a fairly accurate knowledge. Even such old collecting centres as Uitenhage are yielding quite distinct new species, while Conrath's small collection at Modderfontein, near Johannesburg, has yielded such a number of unnamed though well-known forms as to suggest that we may have long been in error in ascribing to Transvaal species, names from the "Flora Capensis" which really belong to species restricted in distribution to the Cape Province, or in a few cases even to Europe.

Publications.

It is desirable for several reasons (*e.g.*, to show Parliament value for the money expended) that the results of the survey work should be published from time to time, as the material becomes available, in the form of "Memoirs of the Botanical Survey of South Africa," rather than as separate publications scattered through the Annals, Transactions, Proceedings, etc., of various museums and societies. If the work is done by museum staffs, publication should be paid for out of survey funds, and full credit be given to the institution which has done the work. Uniformity of publication should be observed as far as possible throughout the series of memoirs; this might cause a little objection on behalf of men of contributing institutions whose form of publication differed from that of the majority, but no reasonable person would be likely to object to such an obviously desirable arrangement.

Conclusions.

I trust I have made clear to you not only the importance, but also the practicability, of conducting a botanical survey of South Africa, even under existing conditions. I am deeply impressed with the necessity for such a survey, and in order to set the ball rolling in the direction of a practical effort, I am arranging to bring before the Scientific and Technical Committee of the Department of Mines and Industries a proposal to call a Botanical Conference on the lines suggested here.

SECTION D. — EDUCATION, HISTORY, MENTAL SCIENCE, POLITICAL ECONOMY, GENERAL SOCIOLOGY AND STATISTICS.

President of the Section: Rev. B. P. J. Marchand, B.A.

THURSDAY, JULY 5.

The President delivered the following address:—

I propose to discuss—very briefly, seeing that I was called upon to preside at the meetings of this Section at very short notice—some points in reference to progress in educational matters.

There are, one is glad to note, considerable and encouraging movements in the direction of solving the problems connected with (*a*) industrial instruction, with (*b*) bringing into school the large number of children who are still outside, and with (*c*) educating the public in the protection of child life.

In a paper read by Mr. W. J. Horne at the Annual Session of this Association in 1915,* he advocated very strongly the claims of vocational education. The National Advisory Board for Technical Instruction has already done, and is doing, excellent work in this direction. There are now in existence also the Juvenile Advisory Boards established by Government in Capetown, Durban and Johannesburg. In Capetown this Board has put itself into communication with the Cape Division School Board, and cards are provided to the teachers at the different schools for registering the pupils who are anxious to be employed in a particular trade. Lists are also made out of the pupils that are likely to leave school at the end of a term. In this way employers and apprentices are brought into relationship. An indenture form is being prepared by the Advisory Board, on which, I may say, the trades are represented, and in this form compulsory attendance at an evening school or continuation classes is a chief feature.

An endeavour is also made to include compulsory attendance at day schools for vocational or general instruction. Pressure is also exerted to make compulsory day attendance at school a feature in the agreement entered into by apprentices in the Government and City Council offices.

This year a beginning will be made with the erection of an up-to-date Technical Institute, which will cost about £40,000, on a most central site granted by the Corporation of Capetown. The character of this Institute has not been finally settled, but there is no doubt that it will take the form, more or less, of a Trades School, at the outset at any rate.

At present there are in connection with the Cape School Board five night schools, with an attendance of 386 pupils, and

*Rept. S.A. Assoc. for Adv. of Science, Pretoria (1915), 694-717.

two technical night schools, with an attendance of 556, while in the ordinary day schools there are over 1,500 pupils who take a full domestic science course, and over 2,000 that take woodwork. It is felt, however, that night work is not altogether satisfactory, and that all apprentices should attend day classes.

The only trade schools that we have as yet in the country —if we except the trade schools in Johannesburg—are confined to institutions that deal with poor boys and girls whose board is also provided for. These are enabled to keep going by contributions from churches and private individuals.

The question as to whether trade schools as they have them in Holland—which are attended by pupils *before employment*—ought to be started throughout the Union has yet to be settled, but a serious attempt is now made to adopt the system of daylight continuation classes concurrently with employment.

But is there not needed something more? The State can provide trade schools and technical institutes for those who have reached the compulsory school-going age, and a certain standard. But do we not need further State supervision of those who leave school at 15 with a limited education, and drift into blind-alley occupations which offer an apparently good wage, but leave them at 18 a drug in the market? Do we not need " a compulsory extension of the age at which a boy or a girl is allowed to drop all educational training and to plunge into his or her life-work without any further supervision or guidance "? Mr. Arnold Freeman proposes the following remedies, and it will be well seriously to consider whether we ought to supply them:—

1. The statutory reduction of the hours of juvenile labour.
2. Compulsory continued education.

In the Report of the Committee on Industrial Education presented to Parliament this year, we find several excellent suggestions. Among them there is one on which more stress might have been laid—namely, the provision of rural schools of industry and school farms. I am strongly in favour of agricultural schools at suitable centres, and in connection with the School Boards, and of a type much less elaborate than the fully-equipped and expensive schools at Elsenburg, Grootfontein and Cedara. There is a great need of men as overseers on farms, and it is to meet this need that such schools ought to be started. An experiment has been made at Grootfontein with some 15 poor boys with this in view. And Mr. Thornton assured me that the results were excellent. But Elsenburg and Grootfontein offer an excellent opportunity for the training of teachers for such primary agricultural schools or school farms. And most suitable centres would be the different irrigation settlements that are increasing in the country, and where the number of children is usually large. Such schools could also be opened in the neighbourhood of large towns, where market-gardening and poultry-keeping are remunerative undertakings. There has

been considerable discussion as to the advisability of a uniform elementary school curriculum for the whole Union.

There is, I think, a great deal more to be said for more flexibility in this respect, and for adapting the school course to the environment of the pupils with a special vocational bias, from the lower standards upwards. To illustrate this point. A school at the sea-coast, say at Muizenberg, where there is a marine station, could utilise the environment for interesting the pupils in marine zoology. Another country school could easily familiarize its pupils with the insects of the neighbourhood, which have proved to be either beneficial or harmful. May I throw out the suggestion that our scientific men should arrange for a series of elementary text-books suitable for the lower standards in our schools? Indeed, a great deal of elementary but accurate information on local botany and zoology can be imparted through ordinary "school readers." Perhaps this Association might take this matter into consideration. We know how much has already been achieved in botanical study through the fact that most High Schools for Girls make a speciality of botany in the Matriculation course. To-day we owe the excellent work of lady experts in the Government service and in the University colleges to this fact.

But why begin and end with botany? Zoology offers as engrossing a sphere of investigation. Why should not a school on the coast take it up as regards marine animals? Take, again, the question of the development of electrical energy from water power. There is no doubt of an enormous development in the future along this line throughout the world. In the South of France, owing to the shortness of coal during the present war, numerous munition factories have sprung up at the base of the French Alps, and incredible quantities of shells are manufactured by power derived from the glaciers, to which the French point with pride as their "white coal." It may be argued that in this country there is not much potential energy in our streams. There are, however, districts where this is available, such as the Knysna, the Transkei, the Stellenbosch, Paarl, Worcester districts; and there is the water power of every irrigation settlement. There are portions of the Free State along the Drakensberg, and of Natal, and of the Northern Transvaal. There are parts of Switzerland where small farmers have their own electric installations: the same is the case, I believe, in Norway. Is it not possible that the school course at such places shall bear as much as possible in this direction?

Closely connected with the question of industrial instruction is that of *bringing every child of school-going age into the school.* The task is not so simple even in the case of large centres. Take this as the experience of the Cape Division School Board. In 1906, when the Board came into existence, we found 6,754 children in the schools, and for the most part in unsuitable buildings; the average number of pupils for the quarter ending December 31, 1916, was 15,602. At the present moment

there are about 1,000 more, and nearly all the large schools are overcrowded. We can barely keep pace with the normal growth of the population. To overtake it and the large influx from without means more expenditure on buildings, heavier outlay on equipment, and a continual increase in the number of scholars. This, however, is mainly a question of money. But there is a large number—some 10,000—of children of school-going age in the Cape Province alone, not to speak of the other Provinces of the Union, who are growing up without proper instruction. How are we to reach these? In many cases the people live so far apart that even farm schools are impossible, unless you appoint a teacher for every two or three children, which would mean an enormous expenditure.

An attempt is now to be made to reach these children by an offer of the Provincial Council (Cape) to provide grants of £18 per annum towards boarding such pupils in hostels to be provided by some local authority, say the Church, in the neighbourhood of a suitable central school. The Report of the Committee on Industrial Education (laid before Parliament this year, 1917) goes perhaps a little further in its recommendation of:—

"Provision of *hostels* and *aid* to those already existing, for—

"(*a*) Indigent children attending all schools;
"(*b*) Country children attending town schools or central schools;
"(*c*) Indigent and other young people entering employment and requiring supervision."

The above Committee puts this "provision" under the heading of "Government Action Required." That can only mean that the Government shall bear the whole burden of such hostels. What the Executive of the Cape Province proposes is that some local authority shall undertake this work, the Government aid being confined to assistance towards the rent of the houses, an allowance towards the salary of the Superintendent, and £18 per annum for each pupil boarded. I agree with the latter proposal. A hostel ought to be a home, and a home implies religious and moral control. The body that undertakes to provide the hostel will regulate all that, and obtains the right of full control of the inmates, on condition that it finds any further funds for the upkeep of the hostel. It is to be hoped that advantage will be taken of this, and every effort made to gather in the children from the outlying districts, where the parents are unable to afford sending them to a boarding-school. It is the only practicable solution; it will be the most economical from the State point of view. It will give the best results as far as the pupils are concerned, because they will have the advantage of the large school and of a different environment.

The Report above referred to contains other suggestions, which may be commended or criticized, but time does not permit

me to traverse them. Some of the recommendations of the Committee do not apply to the Cape Division School Board, as what they recommend is already part of its policy.

Another movement which promises fruitful results is the discussion of the problem of *Child Life Protection*. The Conference which met in Capetown last March in connection with the Capetown Society for the Protection of Child Life and the Johannesburg Children's Aid Society, proved how wide a field lies before those who take an intelligent interest in the well-being of the future citizen.

Such subjects as the relation of the municipal authority to the protection of child life and the physical and moral aspects of the education of children, including medical inspection of schools, provision for the feeble-minded or "retarded" children, and the feeding of school children, are eminently subjects that ought to be scientifically studied, for they involve problems of psychology, physiology and biology. I do not intend to go into this to-day further than to call the earnest attention of this Association and especially of Section D, to this matter.

Section E.—ANTHROPOLOGY, ETHNOLOGY, NATIVE EDUCATION, PHILOLOGY, AND NATIVE SOCIOLOGY.

President of the Section.—Rev. Noel Roberts.

THURSDAY, JULY 6.

The President delivered the following address:—

NATIVE EDUCATION, FROM AN ECONOMIC POINT OF VIEW.

Twenty years ago Dudley Kidd prophesied that "When the gold mines have been worked out at Johannesburg, it may be found that our chief asset in South Africa consists of the Native population."* Two decades have passed, and the gold mines are still being worked; but, whatever Kidd meant when he wrote those words, there can be no doubt in the minds of thinking men and women that the Native population is one of the greatest assets of South Africa to-day. We are almost entirely dependent upon the Bantu races for unskilled and domestic labour. Banish the Bantu from South Africa, and we should be faced with the alternative of importing cheap labour from India, China, or elsewhere, or of closing down our mines—gold, copper, tin and coal—our wattle, tea, and sugar plantations, our tobacco and other industries, all of which depend, more or less, upon the cheap labour provided by the Bantu races of this country.†

The economic value of the Native, however, is not to be gauged merely by his utility as a cheap form of unskilled labour. The South African Natives undoubtedly possess many talents, which, if rightly developed, might prove of inestimable value to our country by increasing its production. They possess wonderful gifts in the management of animals, and if scientifically trained, should prove to be most successful breeders of cattle, sheep, goats and poultry. If their natural gifts for husbandry were directed into right channels, our export trade of beef and mutton, of hides and wool, of cotton and tobacco, of cereals and fruit, might be increased an hundredfold; but South Africa, today, is in danger of stagnation because South Africans persist in the narrow view and allow the fear of competition to stifle progress.

* "The Essential Kaffir," p. 408.

† All efforts to supplant native labour on the mines, in agriculture, and in domestic service by the introduction of *European* unskilled labourers, are doomed to failure since European immigrants soon become conscious of their own superiority and their relation to the labour market, and refuse to remain in menial positions.

The Native population of the Union in 1916 was estimated at 4,504,161,* or, say, 2,253,000 males.† the number of Natives employed in the Transvaal Labour Districts in 1915 was as follows:‡ Mines and Works, 228,279; other employ, 53,294; making total of 281,573. I have not been able to get the figures for other parts of the Union, but we shall be well over the mark if we estimate them at 218,427, making a round total of half a million Natives employed in the Union. This leaves a balance of about one and threequarter millions of male Natives who are practically unemployed, for it must be remembered that the greater part of the agricultural work is done by the women. What an enormous difference it would make if the latent energy represented by even half this number could be converted into productive power! And yet year follows year, and nothing is done to develop such a valuable asset. The conversion of this latent energy into productive power can only be effected by education.§

The natural aspirations of the Bantu towards progress and prosperity have always been seriously handicapped by the ignorance of the masses, their want of method, the apparent absence of any powers of application, and by their ingrained faith in witchcraft. Until we can improve the character of the Natives, teach them the lesson of self-respect, convince them of the value of steady work and of scientific method, and fill each individual with the desire for progress, they will remain, not merely an unproductive asset, but a stumbling-block to progress, because they occupy land and consume produce which might be put to more profitable use by others.

There are many difficulties, however, in the way of providing the necessary "education" which is to make the Native a useful and productive member of the community.

The first is to be found in *race prejudice,* and the fear of competition shewn by our own people.

Race prejudice is due to several causes, among which we may mention—(1) *physical repulsion,* which may be compared to the feeling of the normal healthy man towards a dwarf, hunchback or otherwise deformed person.

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* Statistical Year Book of S.A. (1915-16) 1.

† According to last Census returns (1904 and 1911) males numbered slightly over 50 per cent. of total population.

‡ Statistical Year Book p. 211.

§ In order that my meaning may be quite clear I must ask you to consider what I mean by "education." I use this word in the broadest sense possible to indicate not merely the formal training of body and mind in our teaching institutions, but also the deeper impressions made on character by the example of the ruling races and the spiritual influences of religion. The native is being educated whether we send him to school or not. The illicit liquor dealer, the prostitute, and the gambling den are all playing their part in the education of the native to-day, and as long as there is contact between the white and black races the process of "education" will go on, and the sooner we in South Africa realise this, and set to work to control that process, the better it will be for the natives themselves and for the country as a whole.

(2) *To natural attraction towards one's own kind*—"*Ils s'assemblent qui resemblent.*" We see this every day in religion, in politics, in trades unions, and in class distinctions and all the problems of caste, as well as in racial prejudice.

(3) *To the instinct of self-preservation.*—This is the natural legacy from a generation constantly threatened with annihilation by savages.

A close study of the reports presented to the *First Universal Races Congress* in London in 1911 seems to point to the fact that race prejudice may be overcome in the course of time, but however little justification there may be for the existence of this prejudice on moral or physical grounds, the fact remains that to-day it is one of the most serious obstacles to the uplifting and regeneration of the Bantu races of Africa.

Fear of competition is only a variation of the instinct of self-preservation. It may be as well, however, to point out that there are no really serious grounds on which fear of competition from the natives can be based. The mental equipment of the white man is so vastly superior to that of the Bantu that the latter has about as much chance of success in the struggle for progress as a man whose opponent is given fifty yards start in a hundred yards race. Those who croak about the danger of Natives ousting white men from their work seem to take it for granted that as the Native progresses in efficiency the white man will stand still. As a matter of fact, the progress of the white man should be directly proportionate to the progress of the lower race. It is true that the tortoise in the old fable won the race, but it was only because the hare went to sleep! The argument that the development of the latent powers of the Natives should be retarded lest they should beat us in competition appears to me to be an insult to the intelligence of the white man.

Finally, it must be borne in mind that the progress and prosperity of a community or State are directly dependent on the progress and prosperity of every section and individual of which it may be composed.

Another serious difficulty encountered by the advocate of Native Education lies in the *want of self-respect* generally found in the Native character. For centuries the negro races have been taught, by bitter experience, that they are inferior to their white-skinned masters. From childhood all opposition and self-assertion have been crushed, and the effect upon the race may be seen in the want of faith in his own inability shown by almost every individual of Bantu origin. It is true that success engenders self-conceit in many individuals, but even in such cases there is generally an undercurrent feeling of self-consciousness, which in itself indicates weakness of moral fibre.

Now self-depreciation is a serious fault in any character, and in the Bantu races it is largely responsible for the moral depravity and the lack of initiative, application and stamina, of which they are frequently accused. The fact that this self-

depreciation has been going on for centuries makes it doubly difficult to cure: it has become part of the heritage of the Negro race. It can be eradicated only by the exercise of great patience and tact in all our dealings with natives. There will always be the danger of individuals going to extremes and becoming inflated with ideas of self-importance, and though they generally end by making themselves the laughing-stock of their own people as well as of Europeans, for a time, at least, they seriously hamper those who have the welfare of the Bantu at heart. Infinite patience and tact, therefore, are essential qualifications required by those who are in any way responsible for the education and development of the Bantu races, if we are to teach them the lesson of self-respect, and make them a real and living asset to the community and the State.

The greatest difficulty of all is to be found in that *faith in witchcraft*, which is instilled into the minds of Natives in youth, and especially during the rites performed on the attainment of puberty. I have tried elsewhere* to show that witchcraft forms the normal basis on which Native thought is built up, in much the same way as Science is the foundation of life and thought in our "Western" civilization. The border-line between Magic and Science is sometimes a very narrow one. Take, for example, the well-known fact of Science that the growing embryo is affected by the environment or even by a transitory mood of the mother, and compare this with the classical example of Jacob's use of Magic for increasing his own wealth at the expense of his father-in-law.† Such practices are still of every-day occurrence among the "raw," untutored inhabitants of this land. No effort is spared in their endeavour to weave a protective web of witchcraft about the fields and flocks and homes of family and tribe, and a very large part of life is devoted to the observance of rites pertaining to the preservation or enhancement of the fertile powers of Nature.

In common with all believers in witchcraft, the South African Bantu believe in a close interrelation between all the reproductive powers of Nature. Thus the influence of a "fertile" woman (that is, a woman who is the mother of a large family) is regarded as "catching," in much the same way as we look upon influenza, whooping-cough, or measles as "catching" under certain conditions. These people believe that not only are other human beings susceptible to the influences of fertility or sterility, but these conditions or powers may be transmitted to animals and even to the vegetable world. Hence the growth of "fertility rites," which have as their object the regulation of the food supply and the increase of the power and wealth of the family or tribe.

In most of the tribes of the Northern Transvaal there will

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* "Bantu methods of Divination," *Rept. S.A. Assn. for Adv. of Science*: Maritzburg (1916), 397-408.

† Genesis xxx. 37-43.

be found a hut called the "*Ntola oa Koma*,"* which is at once the focus and the source of all the fertility rites of the tribe. It is a sacred shrine and taboo to all uninitiated persons. The hut itself is of phallic design, and consists of a central chamber enclosed within an outer one. In the dark recesses of the outer chamber or passage are stored the *dikomana* or magic drums,† which are consecrated by human sacrifice, and play a large part in fertility and in war rites. These drums are regarded as the earthly shrine of the tutelary spirit of the clan in much the same way as the Ark was looked upon as the earthly tabernacle of Jehovah by the Israelites. Beyond the drums is placed the store of sacred seed, which I will describe presently. The central chamber is separated from the outer one by a wall of stone. All newly-married couples spend the first few nights of their wedded lives within the sacred precincts of this hut, in order that a numerous offspring of their union may be assured; and it is used as a dormitory for girls during the rites which are practised on attaining the age of puberty, with the same purpose in view. The effect of the continuous use of the *Ntloa oa Koma* for this purpose, especially by those who subsequently present the tribe with large families, is a reflex one, and the efficacy of the building is reinforced. The interrelation of the fertile powers of human beings and of the crops is illustrated by the store of seed already mentioned. This consists of a hollow vessel resembling one of the cylindrical seals used by the ancient Babylonians in general shape, made of a composition of cow-dung and beeswax, in which seed is stored in layers, separated in at least one tribe (Moletshie) by layers of human skin. At sowing time each householder is given a few grains from this store, which he mixes with the seed he is about to sow, in order that the fertility absorbed during storage in the Kauma hut may be imparted to the subsequent crop. Kidd's description of the Zulu custom of cutting up certain organs from the body of a man and scattering them over the fields to ensure fertility is another example of the same kind.‡ It would be possible to enlarge upon this subject for hours, but I think the few examples I have quoted should suffice to make my point clear when I plead that *until faith in witchcraft is eradicated it will never be possible to educate the Natives in scientific methods of stock-farming and agriculture*. At present all the methods and practices of civilized man are regarded as merely the superior magic of the white man. Let us now consider *what has been done* for the education of the Bantu in South Africa.

The first and most important factor in their education is found in the *example set by white men*.

* This apparently corresponds with the "Egbo" house of the Bantu of Central and West Africa described by Amaury Talbot: "In the Shadow of the Bush."

† Described in "Bantu methods of Divination," *Rept. S.A. Assn. for Adv. of Science*, Maritzburg (1916), 397-408.

‡ Kidd: "Savage Childhood." Appendix C, p. 291.

I put this first as it affects practically the whole race. Probably the earliest impression of the white man and his ways is gained from the trader who establishes himself in the neighbourhood of the kraal. In many cases these traders are men of good reputation, and set an example of probity and integrity which cannot be gainsaid. In a very large number of cases, however, the reverse is true. Far removed from the restraining influences of public opinion, and living in a strange, moral atmosphere, the downfall of the man's character is sure and rapid. The curious machinations of the Natives' minds while engaged in barter, their unjust suspicions of the trader when he is trying to deal fairly with them, the ease with which they are deceived, their false ideas of value, their want of logic in some things and their unfailing logic in others, are bewildering at first, but in the end the trader profits by his superior intelligence, and wins a fortune from his trade by means which, viewed in the light of strict morality, are at least questionable. As a race we are proud of our traditions of morality. We are jealous of the purity of our stock. The maintenance of close relations with one of dark-skinned race spells social ostracism; and no taunt stings more deeply than the accusation of there being "a touch of the tar-brush" in a man's nature. But, far removed from the eyes of their fellows, and surrounded by unaccustomed temptations, sooner or later most of these men fail in their obligations to their race, and instead of preserving that attitude of aloofness which exalts them in the eyes of their fellow-men, white and black, they sink to the level of the savages among whom they dwell. The whole problem of the undeveloped races is most seriously affected by the bastard race which is growing up in South Africa to-day as the result of the practice of concubinage by traders and others in isolated regions. The cumulative effect of the example of these scions of civilization is to lower the standard at which the Bantu aims. The Native does not respect the white man any the less, but the standard at which he aims is lower, and this is bad for him on the principle that

"He who aims the sky shoots further far
Than he who means a tree."

The consequence is that when he migrates to the towns in search of employment, experience and wealth, his awakening is often a very rude one. He finds he is not able to imitate the white man who used to be his model at home. Any attempt at familiar intercourse with a white woman may even endanger his life. He soon discovers this, however, for he is an adaptable creature, and moulds himself to the ways of his employer, but all the while he observes the habits of those around him, and his education for good or for ill progresses. If he is engaged on the mines, he probably learns to gamble and to drink. Perhaps, in his ignorance, he may be convicted of a breach of the strange Pass Laws, and finds himself in prison in company with others more evil than himself, who teach him to regard

the white man's law as something not to be worshipped (as he was taught to worship the law of the kraal), but as something to be overcome or evaded by cunning and wile. In this way the process of educating the Native is going on to-day till often he becomes a nuisance to the State and a menace to society.

On the whole, therefore, it must be confessed that the lessons learned from the example and environment of the white man, and from contact with civilization, do not tend to uplift the Native character, since few Natives have that power of discrimination which comes from experience and from intimate association with those of higher ideals than themselves.

The influence of the white man and his civilization upon the Bantu, however, is not always a baneful one. The result of the work of the *Native Affairs Department*, for example, is most encouraging. As far as my personal observations have led me, I cannot speak too highly of those engaged in this branch of State Administration. As a general rule, the example set by officials is a good one, and the paternal interest in the Bantu people shown by them, coupled with the administration of impartial justice and firm discipline, is bound to bear good fruit in the character of the people with whom they deal; indeed, results may be seen even to-day in the staunch loyalty of the Chiefs and their real affection for the "Government" which protects them.

The influence of a Government Department, however, is not far-reaching enough to penetrate to the home life and religious observances on which character is really moulded. This can only be done by an appeal to the psychic and moral side of man's nature, and such an appeal is outside the province of the Native Affairs Department. The following extract from the Report of the Select Committee appointed to investigate the question of "*Assaults on White Women*" points to the same conclusion:

> The evidence of the effect of Christian teaching and education on the character of natives is very strong. These unquestionably exercise an enormous influence for good. Administrative action can go but a short way in that direction. It is a universal complaint that the weakening of tribal control is having a disastrous bearing on social and family life. The effect of the introduction of a civilised form of government results necessarily in the discouragement of ceremonies and customs which, though barbaric in European eyes, has important consequences in regard to tribal, paternal and marital authority, and indirectly, on the moral bearing of the community. In this evolution, the Commission is convinced that the restraining and directing influence of the Christian religion and education, if imparted on right lines, are absolutely essential. There is abundant testimony of the benefit derived from these agencies, which should receive the fullest possible encouragement in the interests of the white as well as the black races.*

Testimony of the same kind is borne by those who were responsible for the last "Code" of Native Education in the Transvaal, and by numbers of experts who have examined the question from an unbiassed point of view.

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* Report of Commission on Assaults on White Women, § 189.

It is therefore to *Christian Missions* that we look for an instrument which will enable us to build up the character of this primitive race. As a close student of missionary methods, I would strongly emphasize the value of these reports. At the same time, I feel that more stress should be laid on a danger which is faintly indicated in the saving clause in the report just quoted, namely, that it is absolutely essential that the Christian religion should be imparted "on right lines." It is obviously impossible for an individual to define the meaning of this clause, for there would always be a tendency to interpret it in terms of his own faith or experience. Having made this confession, however, I feel it my duty to attempt the impossible on the grounds that scientific and human progress are largely dependent on the mistakes as well as the discoveries of earlier workers. Hence, if I am right in any of my conclusions, they may be of service to students of this difficult problem, and if I am proved to be wrong I shall be the first to acknowledge it.

My observation of missionary methods, coupled with my judgment of the mentality of the uncultured Bantu, has led me to the conclusion that the work of the Christian missionary is one which is highly specialized, and therefore requires very special training, and until this fact is recognized by the Churches the results of their work among the Bantu are bound to be disappointing and more or less of a failure. In saying this I do not for one moment wish to discredit the work which has been done, and which is being done. Almost without exception the men who are engaged in this noble work are men of the highest character, and possess all the personal qualifications which are needed in such difficult and self-sacrificing work. The fault lies with those in authority who are responsible for the equipment of their workers, and for the ideals which they set before them. The great failure of missionary work among the Bantu lies in the fact that its outlook has generally been bounded by the limited horizon of the mission station, or the particular Church which that mission represents.

Side by side with this parochial spirit there is often a said want of perspective, and a failure to understand the conditions of Native thought and life. Over and over again I have heard young missionaries asking questions of Natives which revealed a complete ignorance of the mental calibre of the black races. This is not the fault of the individual missionary, for it takes some time for a young worker straight from the intellectual atmosphere of the University to realize that the plane of thought to which the Native has attained is vastly inferior to his own. It is just here that the danger lies, for the teacher naturally presents to his pupils those aspects of religion which appeal most strongly to his own nature, and when he finds that his converts follow his "direction" with all obedience and docility, he is satisfied that his efforts are bearing good fruit.

The mere conformation to the externals of religion, however, is no criterion to the effect of that religion upon character.

This is true, of course, even of more cultured people, but among men who have only reached the stage of development of the Bantu *of the present day* the danger is intensified many-fold.

R. H. Nassau* is loud in his condemnation of the methods of the early missionaries in West Africa, and describes the results of "a Church which two hundred years ago had baptized members by hundreds of thousands, with large churches, fine cathedrals, schools, colleges, and political backing, and no other form of Christianity to compete with it, [and yet] shows in Kongo to-day no results in the matters of civilization, education, morality, or pure religion."

A close study of the methods and aims of South African missionaries to-day has led me to the conclusion that the same danger exists here, though perhaps not in the same degree, as the conditions are somewhat different. Unless missionaries are very careful indeed, there will always be the danger of Native converts regarding Christian rites and ceremonies as the charms and practices of a superior kind of magic. As long as Christianity is regarded in this way Christianity cannot have the power it otherwise would have in uplifting and developing the characters of its converts.

In the course of a paper read before the Central Society for Sacred Study in Johannesburg a few months ago, the writer drew attention to this danger, and in the discussion which followed, a striking confirmation of Nassau's testimony was afforded by one who related his personal experiences on the Eastern borders of Rhodesia a few years ago. During a visit into Portuguese territory he discovered the ruins of a large church which had been built by one of the early Portuguese pioneers, but the only other relics of Christianity he could find were:—

(1) Portions of the wafers used in the celebration of the Mass, which were worn by men of the tribe as charms, and which were credited the power of warding off malaria.

(2) Small images of the Blessed Virgin, which sometimes formed the sole adornment of the women, and which were apparently used as fertility charms.

On the other hand, it is only fair to say that the work of Christian missions in South Africa is not merely superficial. The effect of Christianity upon the lives and characters of thousands of Bantu converts is often marvellous in the extreme.

The high moral plane to which Native Christians sometimes attain may be illustrated by the following incident: About four years ago, while living in Pietersburg, I acted as agent for a friend who left the district to take up work in Natal. This friend left a wagon with a Native blacksmith in one of the locations a few miles from the town, to be sold by him. Several months elapsed, and no purchaser could be found, until one day a Native came to me and offered eighteen pounds for it. I

* "Fetichism in West Africa," p. 211.

accepted the offer and gave him a receipt for the money. A day or two later the blacksmith came to me in a great state of excitement, as he said he had an offer of over twenty pounds for the wagon, and he was evidently very disappointed when I explained that, as the wagon had been paid for, it was too late to do anything. He was not content with this, however, but went to the man who had bought the wagon and spoke to him in such a way that the latter came to me the following day and brought me (I think it was) five pounds, the difference between the price he had already paid and the price which had afterwards been offered for the wagon. He explained that he knew the original owner of the wagon was a poor man, and as a Christian he felt he could not allow him to lose by the transaction. I explained that the deal was strictly in accordance with business principles, and that there could be no legal claim whatever upon him; but he insisted that the moral claim existed, and paid the extra money he felt he owed. Surely this showed a higher sense of moral obligation than most of us here present to-day would have shown, and I am absolutely convinced that it was the direct result of Christian teaching on that man's life!

I have tried to examine the whole problem of the uplifting and development of the Bantu from as impartial a point of view as I can, and the conclusions to which I have come are in close accord with those of Dr. Kelly Miller, who refers to the enormous value of the Church in building up the character of undeveloped races in the following terms:—

> The Negro Church is not merely a religious institution, but comprises all the complex features of the life of the people. It furnishes the only field in which the negro has shown initiative and executive energy on a large scale. There is no other way to reach the masses of the race with any beneficent ministrations except through the organisation that these Churches have established. Indeed, it is seriously to be questioned if any belated people in the present state of the southern negro can be wisely governed without the element of priest-craft . . . . If it were not for the Church the great mass of the negro race would be wholly shut off from any organised influence touching them with any sympathetic intent. . . . Eliminate the Church and the masses of the people would speedily lapse into a state of moral and social degeneration worse than that from which they are slowly evolving. The great problem in the uplift of the race must be approached through the pulpit.*

The relation of Christian Missions to the development and uplifting of the Bantu may be summarized as follows:—

1. Christianity undoubtedly exercises an enormous influence for good upon the character of the Natives.
2. In order to ensure effective and permanent results from Christianity—
   (*a*) European missionaries should be specially trained for the work. In addition to the usual course, this training should include the study of comparative ethnology, and the candidate

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* Kelly Miller LL.D., "Professional and Skilled Occupation": American Academy of Political and Social Science, *Annals*, 49, 14-15.

should have a working knowledge of the principles of magic, together with a clear understanding of the relation of magic to religion.

(*b*) Great care should be exercised in the presentation of any doctrine to ensure clear comprehension on the part of the hearers.

(*c*) *Festina lente* should always be the motto of those engaged in the work of converting the heathen.

Let us now consider

The Lines on which Native Education should be Carried on.

They may be considered under three heads, *viz.*, Physical, Mental and Moral.

1. *Physical.*—It is well to remember that the body is ever foremost in the thought of the Native, as it is with the child, or with the animal. His mind has not been cultivated, and his desires generally seek expression in some physical way. Before the advent of the European, and the restraining influences of civilization, he was able to let loose some of his exuberant spirits in other ways. He could hunt wild animals, he could raid his neighbours and plunder their kraals, as long as he had the power to do so. But under present conditions his natural instincts, and his desire for excitement and violent exercise, find inadequate means of expression, and the result is bad for him.

Greater stress, therefore, should be laid upon *games* for the Natives than has been done hitherto. Every Britisher knows the value of boxing and football as a means for working off feelings of this kind. The man who thirsts for the blood of another feels fully avenged after a good bout with the "gloves," and football provides a valuable substitute for the game of war. Not only do games of this kind serve the purpose of healthy recreation, but the laws by which they are governed educate their devotees in the rules of justice and chivalry.

2. *Mental.*—Men of Bantu race are, as a rule, deficient in those qualities which are required for inductive reasoning, and though their powers of deduction are sometimes wonderfully acute, their conclusions are often sadly discounted by carelessness and inaccuracy. The power to reason inductively is probably what we call a "gift," but it may be subjectively dependent on the development of the faculties through the exercise of deductive reasoning powers. The faculty of reasoning deductively, on the other hand, may be developed by training and practice, and is largely dependent on the habitual accuracy of the individual.

If these premises are true, we are brought to the natural conclusion that if we are to meet with any success in developing the mental capacity of the South African Native, we must first train them to be accurate in their reasoning, and, therefore, more attention should be paid to the mathematical side of Bantu

education, since mathematical studies tend to form habits of accuracy in thought and judgment.

3. *Moral Training.*—I have already tried to show that these people are capable of the highest moral development. On the other hand, it is as well to point out a danger which is not always seen by people who are not well acquainted with the Native character. The real character is often hidden under a heavy veneer of superficiality. In a very large number of cases the real ideal that is aimed at is not *"to be sinless,"* but *"not to be known to sin."* This, of course, is a failing common to all races, but it is especially true of the people we are discussing. The object we have to aim at, therefore, above all things, is to secure purity of motive in all actions.

This high quality of character can only be attained, except in rare cases, by bringing good influences to bear during early childhood, and by jealously guarding the character so formed during the dangerous period of adolescence.

There is something particularly winsome in a Native child who has been well brought up, and teachers in Native schools are often amazed at the intelligence and "promise" of boys and girls of ten or twelve. This "promise," however, is rarely fulfilled, and the time when progress is checked usually coincides with the period of sexual adolescence. During this time the wave of intellectual progress and development ebbs, and it is followed by an overwhelming wave of sexualism which, in many cases, takes entire possession of their natures to the exclusion of every other desire. This, then, is the time of life on which we should concentrate our greatest efforts in our endeavour to stem the tide of debasing influences, and use our utmost endeavour to strengthen the moral fibre of the character of each individual.

How this can be done may be gathered from the cumulative evidence of the history of nations, and the known effect of Christianity upon the Bantu in our own time. In Christian missions we have an instrument ready at hand by means of which the moral character of the Bantu can be uplifted and strengthened. Every encouragement, therefore, should be given to the Churches to enable them to carry on the work they are doing in this direction wisely and well. If they have failed at all during the past, it must be borne in mind that most of their efforts have been made in the face of indifference, if not of direct opposition on the part of the white people; and if they have met with any success at all, it is rather to be wondered at considering the difficulties they have had to overcome.

At the same time, it is well to remember that, had it not been for the work of Christian missions, practically nothing would have been done in the way of providing direct education for the Natives by means of schools. Even now, according to the Statistical Year Book for 1914-15, there is *only one* Government "school for Native children" in the Transvaal, as compared with 260 "aided schools," the greater number of which

have been established and financed by Christian missionary bodies.

If Christian missions are able to do such good work among the Native races of this country, it is obviously the duty of the State to do everything in its power to support and encourage them in that work. The fact that grants-in-aid are made to mission schools may be taken as a proof that the Government recognizes the existence of such an obligation. It only remains, therefore, to see whether these grants-in-aid are adequate, and whether the Government is really fulfilling its obligation towards the Native races.

The cost of education in the South African Union is borne by the Provincial Councils. The expenditure under this head for Native Education, as far as I have been able to get the figures for last year, was as follows:—

Natal	£21,587*
Orange Free State	£4,858†
Transvaal ("Coloured")	£29,126‡
Cape Province	£100,000§

This makes a total of £135,571.||

The total amount produced by direct taxation of the Bantu last year was £863,731 4s. 3d.¶ The direct benefit received from the Government by the Natives may be roughly indicated by adding the amounts voted to the administration of Justice (Native Affairs Department) (£294,426), to the amount devoted to Native Education (£135,571), making a total of £429,997. If these figures are correct, the excess of revenue from direct taxation over direct expenditure on the Natives last year amounted to £433,734!

I am unfortunately not in the position at the present moment to verify these figures, but I believe I am well within the mark.

I am not here to-day as the representative of morality and justice, but I merely quote these figures to show that the Government can and should do far more than it is doing to-day in the matter of educating and developing one of its greatest assets, the Bantu population.

The Native problem is acknowledged by all to be the most difficult problem with which our statesmen are faced to-day, and it is only by recognition of the principle that the progress and prosperity of South Africa as a whole must depend on the progress and prosperity of *every* section of the community that a satisfactory solution can be found.

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* Statistical Year Book of South Africa, 1915-16, p. 303.

† *Ibid.*, p. 312.

‡ This apparently includes "coloured" as well as Bantu schools. I believe the amount for "native" schools only amounted to £18,000.

§ I have not been able to get the exact figure devoted to native schools by the Cape Provincial Council, but I have been told by one who had seen the figure that it was about £100,000.

|| It is interesting to compare this figure with the amount of £2,241,797, which is the sum spent on primary and secondary education in the four Provinces (exclusive of expenses incurred by the Public Works Department, etc.), during the same period!

¶ The total revenue from natives in 1910 was £1,419,904 3s. 3d.

LIST OF PAPERS READ AT THE SECTIONAL MEETINGS.

SECTION A.—ASTRONOMY, MATHEMATICS, PHYSICS, METEOROLOGY, GEODESY, SURVEYING, ENGINEERING, ARCHITECTURE, AND IRRIGATION.

MONDAY, JULY 2.

1. Address by Prof. W. N. ROSEVEARE, M.A., President of the Section.

TUESDAY, JULY 3.

2. Ionisation of gases and the absorption of X-rays: L. SIMONS, B.Sc.
3. Parallax of the faint proper motion star near Alpha of Centaurus: R. T. A. INNES, F.R.A.S., F.R.S.E.

WEDNESDAY, JULY 4.

4. Some problems in terrestrial physics that require attention from South African physicists: Prof. J. T. MORRISON, M.A., B.Sc., F.R.S.E.
5. The scope of radiology: J. S. VAN DER LINGEN, B.A.

THURSDAY, JULY 5.

6. An electric vehicle charging plant: J. W. KIRKLAND, M.Am.I.E.E.
7. The plough: W. S. H. CLEGHORNE, B.Sc., A.M.I.Mech.E.
8. Mechanical refrigerators: H. W. BULL.
9. The effect of vegetation on the rainfall of South Africa: H. PEALING, M.Sc.

SECTION B.—CHEMISTRY, GEOLOGY, METALLURGY, MINERALOGY, AND GEOGRAPHY.

TUESDAY, JULY 3.

1. Address by Prof. M. M. RINDL, Ing.D., President of the Section.
2. The geology of the neighbourhood of Stellenbosch: Prof. S. J. SHAND, Ph.D., D.Sc., F.G.S.

WEDNESDAY, JULY 4.

3. Description of a Bacterium which oxidises arsenite to arsenate, and of one which reduces arsenate to arsenite, isolated from a cattle-dipping tank: H. H. GREEN, D.Sc., F.C.S.
4. An old report on the copper field of Namaqualand: A. W. ROGERS, M.A., Sc.D., F.G.S.
5. Note on the micro-titration of arsenic: H. H. GREEN, D.Sc., F.C.S.

THURSDAY, JULY 5.

6. Note upon the analysis of soda-sulphur dips: B. J. HILL.
7. Sea-bamboo (*Ecklonia buccinalis*) as a source of potash: G. F. BRITTEN, B.A.
8. Simple expedients in experimental chemistry: Prof. B. DE ST. J. VAN DER RIET, M.A., Ph.D.
9. Experimental expression of the relationship between the content of a foodstuff in anti-neuritic hormone and the period of healthy survival of animals upon it: H. H. GREEN, D.Sc., F.C.S.
10. The vitamine content of maize and maize milling products, and the ambiguity of its relation with the phosphoric oxide content: H. H. GREEN, D.Sc., F.C.S.

11. On the fate of arsenic after ingestion by livestock, and after absorption through the skin in dipping: H. H. Green, D.Sc., F.C.S.
12. The place of protein in nutrition: J. C. Ross, B.A., Ph.D.
13. A South African iron industry; prospects and possibilities: Prof. G. H. Stanley, A.R.S.M., M.I.M.M., M.I.M.E., F.I.C.

Section C.—Bacteriology, Botany, Zoology, Agriculture, Forestry, Physiology, Hygiene, and Sanitary Science.

TUESDAY, JULY 3.

1. Intestinal protozoa in relation to the war: Prof. H. B. Fantham, M.A., D.Sc., A.R.C.S., F.Z.S.
2. Blood protozoa in relation to the war: Prof. H. B. Fantham, M.A., D.Sc., A.R.C.S., F.Z.S.
3. Some suitable materials for paper-making: J. Leighton, F.R.H.S.
4. Note on a new genus of Copepoda from a fresh-water fish: Prof. E. J. Goddard, B.A., D.Sc.
5. A plea for Vermian Parasitological Research, with reference to South African Domestic and Native Animals: C. S. Grobbelaar, M.A.
6. A plea for greater attention to physiology in the teaching of Zoology: Prof. E. J. Goddard, B.A., D.Sc.
7. The classification and affinities of the Hirudinea: Prof. E. J. Goddard, B.A., D.Sc.
8. Some field results of fertilising maize: J. F. W. Gatherer.
9. The Hemichorda and their significance in relation to the Invertebrata and Chordata: Prof. E. J. Goddard, B.A., D.Sc.
10. Note on the origin of Metamevism: Prof. E. J. Goddard, B.A., D.Sc.
11. Some notes on the coloration of reptiles and amphibians found near Kimberley, C.P.: J. H. Power.
12. *Fomes applanatus* (Pers.) Wallr. in South Africa, and its effect on the wood of Black Ironwood trees (*Olea laurifolia*): P. A. van der Byl, M.A., D.Sc., F.L.S.
13. The suppling-kiln as a means of destroying insects boring in wood: C. W. Mally, M.Sc., F.L.S., F.E.S.
14. The grain bug or *Stinkvlieg* (*Blissus diplopterus* Dist.): C. W. Mally, M.Sc., F.L.S., F.E.S.
15. Linseed oil as an insecticide: C. W. Mally, M.Sc., F.L.S., F.E.S.

WEDNESDAY, JULY 4.

16. Address by J. Burtt-Davy, F.L.S., F.R.G.S., President of the Section.
17. The ascent of sap in plants: Prof. H. A. Wager, A.R.C.S.
18. South African Myxomycetes: Miss A. V. Duthie, M.A.
19. Variation in *Ageratum conyzoides* (Family Compositae): S. G. Rich, M.A., B.Sc.
20. The plant succession in the Thorn Veld: Prof. J. W. Bews, M.A., D.Sc.
21. Some factors in the replacement of the ancient East African Forests by wooded pasture land: C. F. M. Swynnerton, F.L.S., F.E.S. F.R.H.S.
22. Geographical distribution of the South African Bryophyta: T. R. Sim.
23. Notes on the genus *Myrstropetalon* Harv. (Balanophoraceæ: Prof. R. Marloth, M.A., Ph.D.
24. A key to the families and genera of Spermatophyta in the Transvaal and Orange Free State: J. Burtt-Davy, F.L.S., F.R.G.S.

THURSDAY, JULY 5.

25. A preliminary note on dwarfs appearing in Gluyas Early (Wheat) hybrids: J. H. Neethling, M.Sc.

26. The volatile acidity of wine; particularly that produced by pure cultures of yeast: A. I. Perold, B.A., Ph.D.
27. Notes on anhydrous liquid hydrocyanic acid as a fumigant: C. W. Mally, M.Sc., F.L.S., F.E.S.
28. Opportunities for the selection and breeding of desirable strains of beneficial insects: C. W. Mally, M.Sc., F.L.S., F.E.S.
29. Natural enemies of the Argentine ant, *Iridomyrmex humilis* Mayr.: C. W. Mally, M.Sc., F.L.S., F.E.S.
30. Notes of fibre produced from some of the most useful indigenous and exotic plants in the Cape Province: J. Leighton, F.R.H.S.

FRIDAY, JULY 6.

31. Plant toxins, a cause of infertility in soils: a South African observation: A. Stead, B.Sc., F.C.S.
32. Some phases of applied entomology in South Africa: E. S. Cogan, M.A., Ph.D.
33. An interesting case of insect mutualism: Rev. N. Abraham, F.R.M.S.
34. Hermaphroditism in *Metanastria pithyocampa* Cram.: F. W. Pettey, B.A.
35. The respiratory organs of a notonectid: S. G. Rich, M.A., B.Sc.
36. The respiratory rectum of the nymph of *Mesogomphus* (Odonata): S. G. Rich, M.A., B.Sc.
37. A suggested mechanism for the inheritance of acquired characters: T. F. Dreyer, B.A., Ph.D.
38. The woolly aphis (*Eriosoma lanigera*) as a factor in apple culture: C. W. Mally, M.Sc., F.L.S., F.E.S
39. *Nocardia cylindricca*: a South African Otomycosis: W. E. de Korte, M.B., M.R.C.S., L.R.C.P.

Section D.—Education, History, Mental Science, Political Economy, General Sociology, and Statistics.

TUESDAY, JULY 3.

1. Sansculfotised literature in France: Prof. R. D. Nauta.
2. The proposals for a league of peace—British and American: Rev. R. Balmforth.

WEDNESDAY, JULY 4.

3. Neglected Imperial assets: Mrs. J. F. Solly.
4. Ars Sophoclis interpretandi: with special reference to the Trachiniai: H. G. Viljoen, B.A., D.Litt.
5. Note on the relation between mind and body: Prof. T. M. Forsyth, M.A., D.Phil.
6. Notes on Irving Fisher's Theory of Gold: A. Aiken.
7. National Gilds—a hint toward reconstruction: R. T. A. Innes, F.R.S.E., F.R.A.S.
8. Agricultural education in South Africa: A. I. Perold, B.A., Ph.D.

THURSDAY, JULY 5.

9. Address by Rev. B. P. J. Marchand, B.A., President of the Section.
10. Agricultural education in Australia: C. F. Juritz, M.A., D.Sc., F.I.C.
11. Some sense defects psychologically considered: Rev. F. C. Kolbe, B.A., D.D.
12. F. W. Foerster and some neglected factors in education: Rev. Prof. J. I. Marais, B.A., D.D.
13. The philosophic limits of science: Rev. S. R. Welch, B.A., D.D., Ph.D.
14. A plea for the classics in women's education: Miss K. M. Earle.
15. Industrial development: K. Austin, M.Am.I.M.E.

FRIDAY, JULY 6.

16. The grasses of the Eastern Coast belt available for the manufacture of paper: C. F. Juritz, M.A., D.Sc., F.I.C.
17. The movement towards a national system of technical education: W. J. Horne, A.M.I.C.E., A.M.I.E.E.
18. The decimal system; measures, weights, coinage: W. J. Horne, A.M.I.C.E., A.M.I.E.E.
19. Entomological education in the United States: E. S. Cogan, M.A., Ph.D.
20. Markets: P. J. du Toit.

Section E.—Anthropology, Ethnology, Native Education, Philology, and Native Sociology.

TUESDAY, JULY 3.

1. Binet-Simon tests on Zulus: S. G. Rich, M.A., B.Sc.
2. Our language and the native pupil: S. G. Rich, M.A., B.Sc.

WEDNESDAY, JULY 4.

3. Wit and wisdom of the Bantu, as illustrated by their proverbial sayings: J. McLaren, M.A.
4. The origin and meaning of the name "Hottentot": Rev. Prof. J. du Plessis, B.A., B.D.

THURSDAY, JULY 5.

5. Address by Rev. N. Roberts, President of the Section.
6. Native ideas of cosmology: Rev. S. S. Dornan, M.A., F.G.S.
7. The alleged arrest of mental development in the native: C. T. Loram, M.A., LL.B., Ph.D.
8. The future of the Bantu people: W. Hay, J.P.

FRIDAY, JULY 6.

9. The need and value of an academic study of Native Philology and Ethnology: Rev. W. A. Norton, B.A., B.Litt.
10. Stenography as an aid to the phonetic analysis and comparison of Bantu languages: Rev. W. A. Norton, B.A., B.Litt.
11. Sesuto etymology: Rev. W. A. Norton, B.A., B.Litt.
12. Bantu place names in the Cape Province: Rev. J. R. L. Kingon, M.A., F.L.S.
13. Some Central African folk-lore tales: Rev. J. R. L. Kingon M.A.,

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SEA BAMBOO (*ECKLONIA BUCCINALIS*) AS A SOURCE OF POTASH.

By Gilbert Frederick Britten, B.A.

(*Plates* 2-3.)

During the past few months the author has been engaged in carrying out laboratory experiments to determine whether it was possible to establish in South Africa an industry for the manufacture of a chemical which had hitherto been entirely imported, and which there was reason to anticipate could be more profitably made here. The results of these investigations are not yet ready for publication, but I may mention that in the search for raw materials I was led to a consideration of the available sources of potash in South Africa, and of these I determined to examine seaweed, and more particularly that variety of seaweed which abounds in proximity to the shores of the Cape Peninsula known as sea bamboo. The literature upon the subject, regarded from a South African standpoint, is not very informative. In 1908 Juritz* drew attention to the possibility of seaweed as a source of potash, and quoted extensively from various European and American authorties, mentioning that in the Channel Islands

> the practice obtains of allowing the seaweeds to dry near the shore, and stacking them, when dry, near the houses, to be used as fuel constantly kept burning on the hearths. The ash thus obtained is sold at about 6d. per bushel, and is applied to the soil at the rate of 2½ tons per acre when the wheat is sown. The ash thus applied is probably very imperfectly burnt, but Golfier-Besseyre has found that many a seaweed ash as obtained in practice, contains up to and over 50 per cent. of water-soluble salts. These salts have yielded the following percentage results upon analysis:—

Potassium sulphate	11 to 44
Potassium chloride	12 to 35
Sodium chloride	9 to 70
Sodium sulphate	0 to 35
Sodium carbonate	0 to 15

More recently, Lundie and Hallack† have undertaken the analysis of several kinds of seaweeds growing adjacent to the coast-line of the Cape Peninsula. The following table is taken from their report:—

* "The Utilisation of Seaweeds for Manurial Purposes and in other Industries": *Agric. Journ. C.G.H.* (1908), 501.

† *Rept. S.A. Assoc. for Adv. of Science*, Capetown (1910) 186.

	Water.	Organic Substance.	Nitrogen.	Ash.
Sea grass (*Enteromorpha intestinalis*)	77.44	17.64	.567	4.80
Algæ (*Ulva lactuca*)	78.04	18.8	.35	3.16
*Fucus palmatus** ("sea bamboo") ...	86.42	8.71	.071	4.87

The Ashes of these substances contained:—

	Lime.	Potash.	Phosphoric Oxide.
Sea grass	28.58	16.01	4.48
Algæ (Sea Point)	28.96	11.34	5.57
Algæ, 1st sample (False Bay)	19.87	—	6.9
Algæ, 2nd sample (False Bay)	21.78	9.5	9.98
Fucus (Sea Point)	9.48	30.9	6.59
Fucus (False Bay)	7.16	44.31	3.87

The information so far available did not, however, disclose exactly what was required, and this resulted in my carrying out analyses to determine the nature and amount of the soluble salts of the ash of the sea bamboo. Samples were selected from various parts of the Cape Peninsula, two being obtained at different spots on the coast at Sea Point, one at Clifton-on-Sea, and one at Camp's Bay. The analysis of these samples is as follows:

TABLE I.—COMPOSITION OF FRESH PLANT.

Locality	Sea Point.		Clifton-on-Sea.		Sea Point.		Camps Bay.	
	Stems.	Leaves.	Stems.	Leaves.	Stems	Leaves.	Stems.	Leaves.
Weight in grammes ...	691	647	745	2260	487	710	761	1430.5
Diameter of thickest portions in millimetres ...	43	—	33 } 38 }	—	33	—	38	—
Thickness of walls of stems in millimetres ..	7.5	—	7.0 } 7.5 }	—	7.5	—	8.5	–
Ratio Stems: Leaves ...	1.07:1	—	.33:1	—	.69:1	—	.53:1	—
Moisture	87.20	81.26	86.18	82.67	85.39	83.59	86.48	81.38
Organic Matter..	7.49	12.91	8.60	12.10	9.76	12.15	8.12	12.79
Ash	5.31	5.83	5.22	5.23	4.85	4.26	5.40	5.83

The samples were ashed, and upon analysis gave the following figures:—

TABLE II.—COMPOSITION OF ASH.

Locality	Sea Point.		Clifton-on-Sea.		Sea Point.		Camps Bay.	
	Stems.	Leaves.	Stems.	Leaves.	Stems	Leaves.	Stems.	Leaves.
Total soluble salts... ...	84.78	83.13	87.30	82.59	84.80	84.03	86.94	82.01
Lime	5.76	6.28	5.06	5.58	5.25	5.75	5.65	7.13
Magnesia	3.59	5.05	3.25	4.62	3.67	5.00	3.68	5.26
Phosphoric oxide	1.04	1.51	1.22	2.28	1.09	1.56	1.25	3.27

* This refers to the same species as the title.

Sea Bamboo growing at Sea Point.

G. F. Britten.—Sea Bamboo as a Source of Potash.

Sea Bamboo washed up at Clifton-on-Sea.

G. F. Britten.—Sea Bamboo as a Source of Potash.

The composition of the water-soluble portion is given in Table III.

TABLE No. III.

COMPOSITION OF WATER-SOLUBLE PORTION, CALCULATED IN TERMS OF WHOLE ASH.

Locality	Sea Point.		Clifton-on-Sea.		Sea Point.		Camps Bay.		Average.	
	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.
Lime	.60	.26	.35	.32	.53	.16	.61	.40	.52	.29
Magnesia	.79	.13	.16	.16	.29	.16	.43	.28	.42	.18
Potash as K_2O ...	37.45	25.38	39.63	25.32	36.58	25.62	39.98	25.44	38.41	25.44
Soda (calculated) as Na_2O	11.14	20.99	11.64	20.60	12.17	21.21	11.01	19.96	11.49	20.69
Carbon dioxide ...	3.29	2.12	2.77	1.87	2.70	1.16	3.16	2.60	2.98	1.94
Sulphuric oxide ...	3.61	7.92	4.45	8.29	4.58	8.55	4.44	9.04	4.27	8.45
Chlorine	34.69	33.30	35.58	33.02	34.32	34.67	35.30	30.85	34.97	32.96
Ratio— Potash : Soda ...	3.36	1.21	3.40	1.24	3.00	1.21	3.63	1.27	3.35	1.23

It will be seen that there are not very great variations in composition, and the conclusion to be drawn would appear to be that the sea bamboo is fairly constant in composition. At this point of the investigation, however, I was fortunate enough to be able to visit Kommetje, a spot where the sea bamboo grows more thickly than at any other place in the Cape Peninsula. There was a heavy sea running at the time, and as the seaweed was growing some distance away from the shore, it was out of the question to take a sample from a growing plant. The beach was, however, strewn in every direction, as far as one could see, with immense quantities of this particular kind of seaweed, and I decided to take what was at my disposal. I selected the largest specimen of a plant evidently freshly washed up, and cut a section from the stem, and took part of the leaves. Some idea of the size may be gathered from the statement that the stem was about 12 feet long, and at the thickest part measured 120 millimetres in diameter, while the walls of the stem were 15 mm. thick. There was no means of taking the whole plant, so that no ratio between stem and leaves is given, nor are the figures for the percentage of moisture and of ash considered sufficiently reliable to be included. The composition of the ash was as follows:—

In Percentages

	Stems.	Leaves.
Total soluble salts	92.08	78.69
Lime	3.10	8.30
Magnesia	2.08	5.78
Phosphoric oxide	.47	2.66

Water-Soluble Portion:

	Stems.	Leaves.
Lime	.76	.23
Magnesia	.40	.19
Potash	46.90	26.67
Soda (calculated) as Na_2O	7.90	17.62
Carbon dioxide	1.93	3.19
Sulphuric oxide	2.53	7.81
Chlorine	40.80	28.87
Ratio—K_2O : Na_2O	5.93	1.51

It was apparent that the very considerable increase in the amount of soluble salts in the stem could be explained in only two ways: either the larger amount of potash was due to the greater maturity of the plant, or the variety growing at Kommetje yielded higher figures. To ascertain which of these views was correct, a sample was taken at Clifton-on-Sea from the *stem only* of a plant about 10 feet in length (exclusive of leaves), the dimensions being, at the thickest portion, 80 mm. in diameter, and walls 13.5 mm. thick, and at the thinnest portion 20 mm. in diameter and solid. Five portions of this, about six inches in length, were taken at equal intervals of the whole length of the stem, and in addition the flat portion adjacent to the leaves was taken as a sixth sample. The analysis of these samples gave the following results.

TABLE No. IV.

Diameter in Thickest Part.	Weight in Grammes.	Percentage of Potash.	Total Soluble Salts. Per cent.
25 mm.	132	35.05	83.3
38 mm.	123	44.91	91.2
45 mm.	167	46.01	91.8
63 mm.	319	45.66	92.8
80 mm.	472	43.81	93.4
—	152	35.65	88.1

(N.B.—The first sample contained the "hold-fast," which may account for the low percentage of potash.)

The figures given above are sufficient to show that it is not only at Kommetje that the plant reaches the condition of higher potash content, but that evidently this increase in amount is due to the greater maturity of the plant.

The hypothetical combination of the various bases and acid radicles is given in Table VI.

TABLE No. VI.—COMBINATION OF BASES AND ACID RADICLES.

Locality	Sea Point.		Clifton-on-Sea.		Sea Point.		Camps Bay.		Average.	
	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.
Calcium carbonate	1.07	.46	.63	.57	.94	.29	1.09	.71	.93	.51
Magnesium carbonate	1.66	.27	.34	.34	.61	.34	.90	.59	.88	.39
Potassium sulphate	7.85	17.23	9.68	18.07	9.96	18.60	9.66	19.66	9.29	18.39
Potassium chloride	52.64	25.47	54.43	24.66	49.46	24.68	55.10	23.49	52.93	24.58
Sodium chloride..	15.84	34.87	15.82	35.05	17.71	37.75	14.91	32.40	16.07	35.02
Sodium carbonate	4.70	4.29	5.57	3.47	4.75	2.05	5.32	4.77	5.09	3.64
Total found.. ...	83.76	82.59	86.57	82.16	83.43	83.71	86.98	81.62	85.19	82.53
Total soluble salts	84.78	83.13	87.30	82.59	84.80	84.03	86.94	82.01	85.06	82.94

The composition of the fresh seaweed has been calculated. and the figures are given in Table No. VII.

TABLE No. VII.—COMPOSITION OF FRESH SEAWEED.

Locality	Sea Point.		Clifton-on-Sea.		Sea Point.		Camps Bay.		Average.	
	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.
Moisture	87.20	81.26	86.18	82.67	85.39	83.59	86.48	81.38	86.31	82.23
Ash	5.31	5.83	5.22	5.23	4.85	4.26	5.40	5.83	5.20	5.30
Lime..	.305	.366	.264	.292	.255	.245	.305	.416	.282	.330
Magnesia	.191	.294	.170	.242	.178	.213	.199	.307	.185	.264
Phosphoric oxide	.055	.088	.064	.119	.053	.066	.067	.191	.060	.116
Potash	1.989	1.480	2.069	1.324	1.574	1.091	2.159	1.483	1.948	1.348
Soda (calculated)	.692	1.224	.608	1.078	.590	.904	.595	1.164	.621	1.093

Calculated on the basis of the air-dry material, the following figures are obtained:—

TABLE No. VIII.—COMPOSITION OF AIR-DRY MATERIAL.

Locality	Sea Point.		Clifton-on-Sea.		Sea Point.		Camps Bay.		Average.	
	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.	Stem.	Leaves.
Ash	41.48	31.11	37.77	30.18	33.20	25.96	39.94	31.31	38.10	29.64
Lime.	2.38	1.95	1.91	1.68	1.75	1.49	2.26	2.23	2.08	1.84
Magnesia..	1.49	1.57	1.23	1.39	1.22	1.30	1.47	1.65	1.35	1.48
Phosphoric oxide..	.43	.47	.46	.69	.36	.40	.50	1.02	.44	.65
Potash	15.54	7.90	14.97	7.64	10.77	6.65	15.97	7.96	14.31	7.54
Soda..	5.41	6.53	4.40	6.22	4.04	5.51	4.40	6.25	4.56	6.13

For the sake of comparison I append (Table No. IX) the composition of kelps from the Pacific littoral of the United States of America. ("Economic Value of Pacific Coast Kelps." Bull. 248, Univ. California, p. 199.)

TABLE IX.—AVERAGE COMPOSITION OF HARVESTABLE LEAVES AND STEMS OF KELP.

		Composition calculated to Water-free Basis.			*Composition calculated as Fresh Material.*			
No. of Samples represented.	Description of Samples.	Percentage of Nitrogen.	Percentage of Phosphoric acid (P_2O_5)	Percentage of Potash. (K_2O)	Percentage of Moisture.	Percentage of Nitrogen.	Percentage of Phosphoric acid (P_2O_5)	Percentage of Potash. (K_2O)
13	Macrocystis leaves, San Diego and La Jolla	1.26	.73	10.71	84.66	.19	.11	1.58
6	Macrocystis leaves, Pacific Grove, and vicinity.	2.67	1.03	12.55	86.91	.35	.14	1.64
19	Macrocystis leaves, San Diego, La Jolla, and Pacific Grove	1.71	.83	11.29	85.65	.24	.12	1.60
13	Macrocystis stems, San Diego and La Jolla	.71	.55	19.49	88.25	.08	.07	2.28
6	Macrocystis stems, Pacific Grove and vicinity..	1.11	.57	22.01	89.29	.12	.06	2.34
19	Macrocystis stems, San Diego, La Jolla, and Pacific Grove	.84	.56	20.28	88.59	.09	.06	2.30
13	Nereocystis leaves, Pacific Grove and vicinity	2.07	.85	18.65	91.37	.18	.07	1.60
13	Nereocystis stems, Pacific Grove and vicinity..	1.23	.52	26.37	91.98	.10	.04	2.10
5	Pelagophycus leaves, San Diego and vicinity	1.55	.83	18.65	88.87	.17	.09	2.05
5	Pelagophycus stems, San Diego and vicinity	1.00	.56	29.52	91.38	.09	.05	2.54

TABLE X.—AVERAGE COMPOSITION OF ENTIRE HARVESTABLE PORTIONS.

No. of Samples represented.	Description of Samples.	*Average Composition calculated to Water-free Basis.* Percentage of Nitrogen.	Percentage of Phosphoric acid (P_2O_5)	Percentage of Potash. (K_2O)	*Average Composition calculated to Fresh Material.* Percentage of Moisture.	Percentage of Nitrogen.	Percentage of Phosphoric acid (P_2O_5)	Percentage of Potash. (K_2O)
13	Macrocystis pyrifera, San Diego and La Jolla.	1.11	.68	13.06	86.08	.15	.09	1.80
5	Macrocystis pyrifera, Pacific Grove and vicinity..	2.21	.92	15.11	87.44	.28	.11	1.88
18	Macrocystis pyrifera, San Diego, La Jolla, and Pacific Grove	1.41	.75	13.63	86.41	.19	.10	1.82
13	Nereocystis luetkeana Pacific Grove and vicinity	1.78	.73	21.20	91.58	.15	.06	1.78
5	Pelagophycus porra, San Diego and vicinity	1.37	.74	22.12	89.92	.14	.07	2.23
2	Egragia lævigata, San Diego and vicinity, complete strands	1.91	1.12	9.12	83.67	.30	.18	1.44
3	Egregia menziesii, Pacific Grove and vicinity, complete strands	2.75	1.25	9.70	83.62	.45	.20	1.59
1	Laminaria andersonii, Pacific Grove and vicinity, entire plant	2.40	0.76	5.87	78.50	.52	.16	1.26
1	Iridæa laminarioides, Pacific Grove and vicinity, entire plant	2.72	0.68	2.26	80.06	.54	.14	0.45

The following figures are taken from the publications of the Board of Agriculture and Fisheries (Leaflet No. 254, "Use of Seaweed as Manure," p. 4) :—

Table XI.—Fresh and Dried Sea Weed.

	Water. Per cent.	Organic Matter. Per cent.	Nitrogen. Per cent.	Potash. Per cent.
Fresh Seaweed—				
Laminaria digitata, stems ("Driftweed," "Tangle,'" etc.)	82.37	12.31	0.23	1.83
Laminaria digitata fronds.. ...	74.75	19.59	0.34	1.28
Fucus vesiculosus ("Wrack,"	68.17	25.29	0.38	.97
Fucus nodosus "Bladder	70.52	23.13	0.33	.78
Fucus serratus wrack," etc.)	75.40	19.08	0.36	1.02
Dried Seaweed—				
Laminaria digitata, stems... ..	—	64.03	1.31	10.49
Laminaria digitata, fronds.. ...	—	77.28	1.30	5.25
Fucus vesiculosus..	—	79.71	1.18	3.07
Fucus nodosus.	—	78.39	1.13	2.52
Fucus serratus	—	77.56	1.50	4.18

Average Potash Content of Ash.

	L. digitata. (stems). Per cent.	*L. digitata.* (fronds). Per cent.	*F. vesiculosus.* Per cent.	*F. nodosus.* Per cent.	*F. serratus.* Per cent.
Potash in Ash.. ...	28.71	20.99	15.29	12.22	18.60

It will be seen by comparison with the tables above given of seaweeds from the coast of America and those of the British Isles that while our South African bamboo (*Ecklonia buccinalis*) is on the whole lower in its potash content than the American weeds, it is decidedly better in composition than any of the analyses quoted from the leaflet of the Board of Agriculture and Fisheries, especially as concerns the stem. The most noticeable feature of the investigation has been the very marked contrast between the constitution of the salts obtained from the stems of the plant and the leaves, but this is not a matter for surprise, as a similar result was obtained in the United States of America. The principal plants of the American Pacific littoral are *Macrocystis pyrifera* and *Nereocystis luetkeana;* both of these grow in huge groves sometimes hundreds of feet in length. The *Ecklonia buccinalis,* on the other hand, though not very much inferior as a source of potash, is not at all similar to the American weeds in appearance. At the present moment I am not aware of any statistics being available as to the distribution of this particular species of algæ; it is reported that it occurs at intervals for some hundreds of miles *north* of Capetown, but whether this is so can be ascertained only by a proper marine survey of our coasts.

Undoubtedly the chief use for the seaweed at the present time would be as a fertiliser, and it is quite within the range

of possibility that in time the huge quantities of seaweed which are at our disposal may be used not only to supply our own needs in this respect, but to furnish raw materials for industries at present dependent upon oversea supplies.

It is a question for practical investigation whether, when used for fertilisation, it should be applied as harvested or after being ashed. The Board of Agriculture and Fisheries, in the leaflet quoted above, recommend its direct application to land, remarking that:

Seaweed contains about as much nitrogen as farmyard manure, but, as it is present as slow acting organic nitrogen, it is scarcely so valuable as in average dung in which a certain proportion is present in the active available form of soluble ammonia compounds. As the seaweed decays rapidly in the soil, however, some of its nitrogen soon becomes available. The amount of phosphate in seaweed is only about one-half or one-third that of dung; on the other hand seaweed is on the average considerably richer in potash. It will be seen, therefore, that it is desirable as a rule to supplement it with a phosphatic manure. Seaweed contains no fibre, and, consequently, does not produce the black fibrous material characteristic of the dung-heap; in decomposing it forms soluble substances which easily wash away. For the same reason it decomposes more completely than dung. It is even said to facilitate the decomposition of dung on light soils and in dry districts, but there is no definite proof of this. A ton of dung and seaweed would break down in the soil more quickly than a ton of dung alone and would therefore have less of a drying effect if put on late. The freedom of seaweed from weed seeds and from spores of disease organisms is of considerable advantage on light soils where weeds are common, or on soils liable to such diseases as finger-and-toe, the spores of which can hardly be kept out of dung.

Experiments to test the manurial value of seaweed have been made at Trondhjem, at the Rhode Island Experiment Station and by a few workers in Great Britain. In Hendrick's trials seaweed proved fully as effective as dung for early potatoes, so far as quantity of produce was concerned, but it somewhat retarded ripening. On the other hand, seaweed and superphosphate proved better than dung and superphosphate. It is, however, on such gross feeding crops as mangolds and the cabbage tribe that seaweed would be expected to show its fullest effects.

Reference has already been made to the fact that seaweed decomposes more completely than dung, and is converted into soluble or gaseous substances. It should therefore not be allowed to rot in heaps by itself, but should be put straight on to the land, or, if this is not practicable, mixed with dung or other material which will absorb some of the decomposition products. The value of a heap of seaweed is much lessened by exposure to rain but exceptions to this rule may arise in the case of special garden crops.

Juritz (*loc. cit.*) says:—

Nothing being thus, as a rule, gained by making compost with seaweeds or allowing them to ferment, the practice generally is to employ such articles as a green manure by way of top-dressings, or to plough them into the soil while fresh, rapid decay resulting in the production of speedy effects on the crops; while, in consequence of their prolific growth, each succeeding season is likely to place ready to hand a fresh supply of seaweeds.

So rapid, indeed, is the growth of seaweed that at a spot on the Scottish coast where all the growing seaweed had been removed, within six months there was again a thick growth of ribbon kelp two feet long, and of ordinary kelp six feet long.

Cattle are declared to thrive excellently upon the grass resulting from sea-manure and in Jersey particularly this fact is turned to account while parsnips and turnips are cultivated by its aid, suplemented by cow manure; for mangolds it is also largely used; to potatoes, however, it is said to impart a disagreeable flavour. The practice is to plough the fresh seaweed two or three inches into the soil in autumn or winter, following it up in the spring by trench ploughing with 20 to 30 tons per acre of farm-yard manure."

On the other hand, it is a matter open to grave doubt whether it would be possible to profitably apply the dried kelp at any place necessitating transport for any great distance, which would mean that the scope of its utility as a green manure would be limited to those cultivated areas which are adjacent to the coast where the kelp is obtained. The alternative method would be to burn the weed at a low temperature, and either use it as the ash or after leaching out and evaporation of the salts. It is of interest to note that the trunk portion of the thallus dries rapidly in warm weather to a hard brittle condition which would lend itself to rapid incineration. During the process of drying a salt effloresces from the trunk, which is apparently very much simpler in composition than the salt obtained after ashing and leaching. I am indebted to Mr. E. V. Flack for having analysed a small portion of this efflorescence, which gave the following figures:—

Total soluble salts	82.56 per cent.
Chlorine	39.73 per cent.
Carbon dioxide	Trace.
Sulphuric oxide	Nil.
Potash	50.48 per cent.
Soda (calculated)	1.40 per cent.

Equivalent to 80 per cent. potassium chloride and 2.6 per cent. sodium chloride.

It will be obvious that if a method of ashing after drying were adopted, it would be necessary to take precautions not to expose the kelp to rain, and thus lose the valuable constituents. Probably the best results in fertilization would be obtained by admixture of the ash with superphosphate; the immediate effect of this mixing with the superphosphate would be to cause a reversion of a portion of the water-soluble phosphoric oxide in the latter, but this would not be very serious; on the other hand, the mixing would prove beneficial in the end by neutralising some of the free acid invariably found in superphosphate, which is one of the chief reasons, if not the chief reason, for opposition to the use of that fertilizer alone on sour or acid soils. It must be remembered, too, that the chief constituents of the ash are the chlorides of potassium and sodium, which are regarded as injurious for some crops, such as tobacco; generally speaking, however, I do not anticipate that there will be any very great objection to their use, as extended use has already been made in this country of kainit, a fertilizer which contains similar salts, though not nearly so rich in potash.

Another method of utilisation would be to destructively distil the dried kelp in iron retorts on a large scale, the products of distillation being acetic acid, acetone and ammonia, eventually calcium acetate and sulphate of ammonia; the charred residue could then be lixiviated with hot water, and the salts obtained by solar evaporation. This would have the advantage, too, of rendering possible the recovery of iodine from the mother liquor, and would conserve the products of combustion, for which there would be a market in South Africa.

The scope of this paper is purely that of a preliminary investigation; originally it was started from the point of view of utility, but it has gone beyond that to the question of recognising that the subject is one of intense interest from a scientific standpoint, and that the field for investigation is practically unlimited. We have bordering on our coasts hundreds of different varieties of seaweed about the composition of which we know little or nothing. I have made no attempt in this paper to go into the question of the presence of iodine in sea bamboo, nor have I made any determinations of the amount of protein. These, with the problem of the composition of the organic matter—the alguloses, etc., are sufficient to provide for a separate investigation, and I sincerely hope that I have said sufficient to induce someone to take up this question and carry out the necessary analyses.

Reverting to the subject of potash and its use as a manure, I need hardly remind you that, prior to the commencement of hostilities, the potash market was practically controlled by Germany, through her huge deposits at Stassfurt, and that the United States of America found it beyond the question of practical politics to utilise its extensive seaweed groves as a source of supply for its own needs, owing to the prohibitive competitive prices at which Germany could supply pure salts. Since then America has hopes of succeeding in exploiting its own resources. New Zealand has also taken up the question, and is at present carrying out experiments on the same subject. Here in South Africa we have at our very doors large quantities of a seaweed which yields fairly satisfactory quantities of potash. It should be possible on a commercial basis to obtain from the trunk portion an ash containing not less than 33 per cent. of potash, and from the leaves an ash containing not less than 22 per cent. of potash. On the pre-war basis these would be worth at least £8 a ton and £5 10s. a ton respectively. The most urgent need is first of all for an exhaustive Marine Survey to ascertain the extent of occurrence of the seaweed. The opportunity for making the question a success comes at a moment when we are at the parting of the ways; if we seize the opportunity now, we may be successful; if we wait until after the war, it may be too late. Shall we succeed?

In conclusion, I wish to express my thanks to the Government Analyst at Cape Town for permission to carry out the analytical work here recorded.

A SOUTH AFRICAN IRON INDUSTRY: PROSPECTS AND POSSIBILITIES.

By Prof. George Hardy Stanley, A.R.S.M., M.I.M.E., M.I.M.M., F.I.C.

One of the greatest assets of any country is a stable iron and steel industry, and all who have the welfare of South Africa at heart must surely desire to see such an industry established.

Obviously, one of the very first considerations to be taken into account in this connection is the value of iron and steel imported, and reference to the Annual Statements of Trade and Shipping for the Union shows that the total is very large—nearly 6½ millions sterling.

Taking the figures for 1913—the last year undisturbed by abnormal conditions due to the war—it is found that the following are the figures relating to imported goods or materials wholly or very largely composed of iron and steel:

	£
Iron and steel, raw or partly manufactured	946,275
Hardware and cutlery and iron manufactures, N.O.D.	1,704,241
Fencing material	593,542
Machinery, except locomotives	2,842,597
Railway and tramway material	308,110
	£6,394,765

Of this total, roughly half a million sterling relates to articles which are apparently quite outside the possibility of South African manufacture for a long while ahead, but of the remainder it is probable that a considerable portion could be made here, if not with existing facilities, then at any rate in the near future.

Terrible as such an expression of opinion may appear, it is nevertheless the case that the war has not been an unmitigated calamity so far as this country is concerned: many new industries have arisen, and have obtained a footing, with every prospect, in many cases, of a successful future; and undoubtedly much more could and would have been done were it not for the shortage and very high prices of the raw material, caused also by the war.

This is markedly the case in the engineering and allied trades employing iron and steel, for almost without exception foundries are short of pig-iron, and the present price is prohibitive for the manufacture of many items for which there is great demand.

If only pig-iron were available at reasonable price, the quantity which could be absorbed is without doubt several times

the pre-war imported figure for foundry purposes alone, and a very much larger quantity is required after conversion to steel.

Turning again to figures: the importations in 1913, of which some part could be produced here, are as follows:

	£
Machinery, agricultural	209,212
,, mining	829,615
,, water-boring	37,353
,, N.O.D. and parts	937,599
Fencing material	593,542
Hardware and cutlery and N.O.D. (pipes, plate, sheet)	1,704,241
Railway and tramway material, including locomotives	308,110
Raw or partly manufactured iron and steel (sections)	946,275
	£5,565,947

The totals are obviously made up in very large part of a great variety of manufactured articles, which are the products of specialized industries, which it would be impracticable for various reasons to establish here, but to a varying extent in each category we are either already manufacturing, or could manufacture in the country, and in the author's opinion it would not be an unfair estimate of the possibilities if it were assumed that goods to at least the following values could be locally produced:

	£
Machinery, agricultural	50,000
,, mining and water-boring	200,000
,, N.O.D. and spare parts	100,000
Fencing material, standards	60,000
Hardware—axles, springs, bolts, nuts and rivets, stoves, etc.	120,000
Rails, sleepers, etc.	100,000
Raw and partly manufactured iron and steel	400,000
	£1,030,000

Of the above total the major portion would be the product of one or more iron and steel works, which would furnish raw material for the remainder; the annual production of such works might be estimated to be as follows:

	£
Raw and partly manufactured iron and steel	400,000
Fencing standards	60,000
Rails, sleepers, etc.	100,000
Raw material for remaining industries .. .	150,000
Say ..	£700,000

A large proportion would be steel, the remainder pig-iron.

In short, it is estimated that material to the value of rather more than 10 per cent. of the imported total may be produced here.

It must be remembered, too, that these figures relate to values (including packing, etc.), leaving oversea ports: the value here is obviously considerably greater.

The annual value might safely, therefore, be increased to £800,000, and if to this be added increase of price directly due to the war, and which must, to some extent, persist for years yet, the total may, without any undue optimism, be placed at a round £1,000,000.

The mines alone are responsible for an enormous total: for the same year, 1913, the Annual Report of the Government Mining Engineer gives the following consumption of stores, among others, by the mines of the Union:

	Tons.	Value.
Bolts, nuts, washers, and rivets ...	2,394	£57,309
Iron, castings	4,248	102,863
Iron, pig	500	4,900
Iron, bar and angle	4,819	79,504
Rails, crossings, and sleepers	—	250,908
Shoes and dies	7,500	135,516
Steel, hand and rock drill (Transvaal only)	5,633	162,729
Say ...	40,000	and nearly £800,000

All these are comparatively simple manufactures, and could be made here, and besides these items, pipes and pipe fittings, rock-drills and spares, and hand tools amount to nearly £700,000 more, of which, undoubtedly, a portion could be so made.

Added to this we have the requirements of the remainder of the country, and particularly the very large railway requirement, so that the figure of £1,000,000 yearly seems well within the bounds of possibility.

Now, however, another phase of the question needs consideration. Assuming that iron and steel can be made here, would the selling price leave an attractive margin of profit?

There is no doubt that at present prices, if a works were already in existence, very handsome profits would be realised; but at pre-war prices—at least, for many of the lines, and particularly at or near importing ports—it would be extremely doubtful under the existing fiscal arrangements.

It is true that prevailing trade conditions constitute a greater protection for South African industries than anything a Government would be likely to enforce, but capital is very nervous as to the position after the war, and, for reasons stated later, it

is after the war conditions which must be met, since only a very small scale commencement could be made now.

It has already been mentioned, in accordance with the general, though not universal, opinion, that high prices will rule for a long time after the conclusion of war; and in view of the great national importance of the industry, the Government might adopt the suggestion embodied in Mr. Kotze's memorandum of 1909, and institute a bounty scheme in conjunction with a guarantee of interest for a period of years on the capital invested.

Under such conditions the industry could be started without penalizing consumers, and with a reasonable certainty of securing a large proportion of the business.

In course of time the bulk of the inland requirement at least in the lines mentioned could be met at remunerative prices, and once established, a reasonable measure of protection would ensure future stability, and particularly, if, at the same time the rails required for the Government railways were supplied under contract by the works, the amount probably being between 30,000 and 40,000 tons.

A fuller consideration of the financial side of the position would be out of place here, and some consideration may next be given to the plant and materials required.

One or two large modern blast furnaces would be able to produce sufficient pig-iron as a basis for the steel manufacture for a long time to come,

Most of their output would be converted to steel in basic open hearth furnaces, the product of which would constitute the major portion of the works' output, but a onsiderable portion would be further treated in electrical furnaces for the production of steel for special purposes, such as mining drills.

The obtaining of the requisite machinery for these various branches would constitute the chief difficulty at the commencement, and would appear to render a start scarcely possible till after the war, unless it is prolonged to an extent at present considered impossible.

Apart from the machinery, all materials required are undoubtedly available or can be made in the country.

We have ores, fuels, fluxes, refractory material, and other structural material, though possibly some of the last-mentioned might have to be imported.

It is generally supposed that we have iron ores in unlimited amounts, but as a matter of fact there is not much authentic information available. One hears of big bodies of ore in various localities, and sometimes analyses are given, though seldom of representative samples. But usually there is no definite estimate of available tonnage, and it is manifest that a very great deal of work remains to be done in this direction.

However, there are at least two localities in which iron

ores occur in large and workable quantities, one being the Pretoria district, and the other near Maritzburg.

In the former place there are two beds of siliceous ore varying in thickness from 4 to 20 feet, and extending for many miles: one small range alone, south of Pretoria, which can be mined by open-cut and adits, being estimated to contain over 4,000,000 tons of ore, assaying 45 per cent. or over in iron.

Analyses by the author are as follows:—

	per cent.	per cent.	per cent.	per cent.	per cent.
Silica (SiO_2) ...	14.30	17.93	22.1	17.44	21.96
Ferric oxide (F_2O_3)	76.93	73.81	63.75	69.43	65.57
Alumina (Al_2O_3)	7.20	7.31	10.41	7.38	6.54
Lime (CaO)	undet.	undet.	.62	.75	1.20
Magnesia (MgO)	undet.	undet.	undet.	.47	.44
Sulphur	.03	.03	undet.	.014	.014
Phosphorus	.14	.17	undet.	.17	.24
Iron	53.9	51.8	44.6	48.6	45.9

There is also a persistent bed of "clay-band" ore, which outcrops for several miles. It is not so thick as the siliceous ore —about two feet—but is richer in iron, assaying about 50 per cent. An analysis by the author is as follows:—

	per cent.
Silica	7.70
Ferric oxide	73.57
Alumina	7.94
Lime	.45
Magnesia	.33
Sulphur	.029
Phosphorus	.52
Iron	51.5

By mixing this with the siliceous ore, the amount of limestone flux required is very considerably reduced, and not more than 15 per cent. to 25 per cent would be necessary.

Samples from the Maritzburg district assayed by the author showed from 40 to 51.5 per cent. iron.

These occurrences were reported on by Dr. Hatch, for the Natal Government in 1909, and in his report* several analyses are given which show that this ore is a hydrated hematite comparatively low in silica—usually about 5 to 10 per cent.—and assaying 45 to 60 per cent. iron.

Little work had then been done in opening up the deposits, and he was not convinced that workable quantities existed. I am informed, however, that since his visit some prospecting work has been done, and the beds found to exist over a large area, of thickness from 2 to 5 feet, and outcropping for 30 miles.

*Report on Mines and Mineral Resources of Natal: F. H. Hatch (1910).

The ores are rather phosphoric in character, containing about .2 per cent. to .4 per cent. phosphorus.

With regard to flux, a non-siliceous limestone is required, and this is scarce in South Africa. However, two large deposits are known which are stated to be capable of affording millions of tons; one, the best, being at Taungs, and the other near Potgietersrust. The former contains about 1 per cent. of silica, and the latter 1½ per cent., with very little magnesium carbonate in either case.

It would doubtless be possible also to utilize to some extent the dolomite, which in places is sufficiently low in silica. Three of the author's analyses show:—

	per cent.	per cent.	per cent.
Silica	4.15	4.18	1.5
Ferric oxide, alumina ..	4.00	1.05	1.70
Lime	28.66	36.12	26.5
Magnesia	18.10	15.05	20.5

Fuel presents a greater problem; expressed as percentage it would be seen that nearly all the iron output of the world is obtained by smelting with coke, and South Africa is deficient in coking coals.

Natal, however, certainly possesses a very considerable tonnage of coking coal, and has at present three coke producers. Judged by oversea standards, the coke is perhaps not quite of the best quality, but nevertheless it is quite good enough for iron smelting. Some analyses by the author are as follows:—

	per cent.	per cent.	per cent.	per cent.	per cent.
Fixed carbon ...	83.07	84.28	85.68	85.62	84.12
Ash	13.78	14.32	11.25	11.50	13.45
Sulphur	1.37	.79	1.59	1.14	.73
Cell volume	55	57	51	53	undet.
Specific gravity (apparent) ..	1.06	.87	.80	.85	undet.
Compressive strength	1,950 lbs. per sq. inch.	2,000 lbs. per sq. inch	1,100 lbs. per sq. inch.	1,280 lbs. per sq. inch.	good but undet.

The last is representative of the present product of one plant, though probably on the average sulphur would be higher. Cokes of no better quality are in use for iron-smelting elsewhere.

The coke output at present is small—not a quarter of the demand of a prospective iron industry—and no by-products are obtained. The cost of production and price is therefore high.

There is but little coking coal in the Transvaal, and it might not be possible to coke it extensively in competition with Natal; but in this direction also authentic in-

formation is lacking, and a survey of Transvaal coals with respect to their coking possibilities is badly needed.

There are, however, two alternative fuels available. Although, as already stated, only a relatively very small amount of iron is produced other than by coke-smelting, nevertheless, there is a very considerable absolute tonnage smelted by charcoal in Sweden, Austria and the United States, and by raw coal in Scotland.

With respect to the first, a small amount of charcoal, though of somewhat poor quality, is already produced in the Transvaal, and would doubtless be obtainable in larger quantity and lower price if required—it is at present cheaper than coke.

But in this connection Mr. Sim's paper on "The Natal Wattle Industry"* gives food for thought. He estimated that 200,000 tons of wattle timber was burnt to waste per annum, and this should be capable of furnishing 40,000 tons of charcoal besides considerable by-products.

Under the special circumstances obtaining there—*i.e.*, really utilisation of a waste product—charcoal should be very cheaply produced, and enough would be available to keep a very considerable iron industry in operation, since, roughly, one ton of charcoal can produce one ton of iron. Charcoal iron, too, is of the best quality and commands the highest price.

But even if charcoal is neglected there is still coal to fall back upon, and since the Transvaal coal is, as a rule, non-coking, and not unduly given to decrepitation, it should be possible to use it as a blast-furnace fuel as in Scotland, though it may be somewhat high in sulphur.

It would be by far the cheapest fuel, and there are certainly millions of tons available.

Of course, the possibility of using it in this manner could only be definitely settled by actual experiment, and that would cost several thousand pounds; nevertheless, being a matter of such great national importance, it certainly merits Government consideration.

It may be noted, too, that when coal is used in this manner instead of coking it first; by-product plants can also be installed, and tar and ammonium sulphate recovered, both being very much in demand in South Africa. Indeed, in conjunction with basic phosphate slag from the steel furnaces, the industry might be also producing artificial fertilizers for the country's agriculturists.

Refractory materials may be dealt with very briefly. All required firebrick, of whatever character, can be produced of quite satisfactory quality by existing works in the Transvaal, all required material being locally obtainable.

Very much the same can be said of the structural materials, of which cement and ironwork would constitute a large part.

*Rept. S.A. Assn. for Adv. of Sc., Maritzburg (1916), 279-301.

Cement is, of course, a local product, and structural ironwork is already produced to some extent.

Since, therefore, every requisite, including a market, appears to be at hand, sooner or later the industry must come into existence. Indeed, without considering foundries, a beginning has already been made in the Transvaal, where two works are producing rails and other sections at the rate of between 1,000 and 2,000 tons per month; several are making crucible steel castings, and one electric furnace is making stamp battery shoes and dies to the extent of 60 tons per month.

All these, however, are working up scrap material, no pig being yet produced, but the position as regards supplies is so critical that it may have to be met by the erection of a small plant, which there is little doubt could be constructed now, and would, under existing circumstances, be profitably operated.

In 1910 Mr. Harbord reported to the Transvaal Government on the possibility of manufacturing iron and steel in the Transvaal.

His report, based on conditions then obtaining, was unfavourable. Now, however, conditions have changed.

Iron ore and limestone are known to be available; the fuel difficulty can be overcome, and prices have risen enormously.

Moreover, the country, as a whole, in spite of all discouragement, is forging ahead rapidly, with consequent increased demand for iron and steel, and with every prospect of still more rapid expansion after the war.

(*Read, July* 5, 1917).

A GREEN SUN.—The *Journal of the British Astronomical Association* (**27** (1917) [5] 170) contains a short description of the unique phenomenon of a green sun recently seen in Surrey. The setting sun emerged from behind a dark cumulo-nimbus cloud, shining a bright green, and maintained this colour for five minutes as it crossed a clear space between the cloud and a thick haze on the horizon. So green was the radiance that the wet roofs of the houses in the valley all shone with a green light. The sky above the dark cloud was of an orange hue.

THE GEOLOGY OF THE NEIGHBOURHOOD OF STELLENBOSCH.

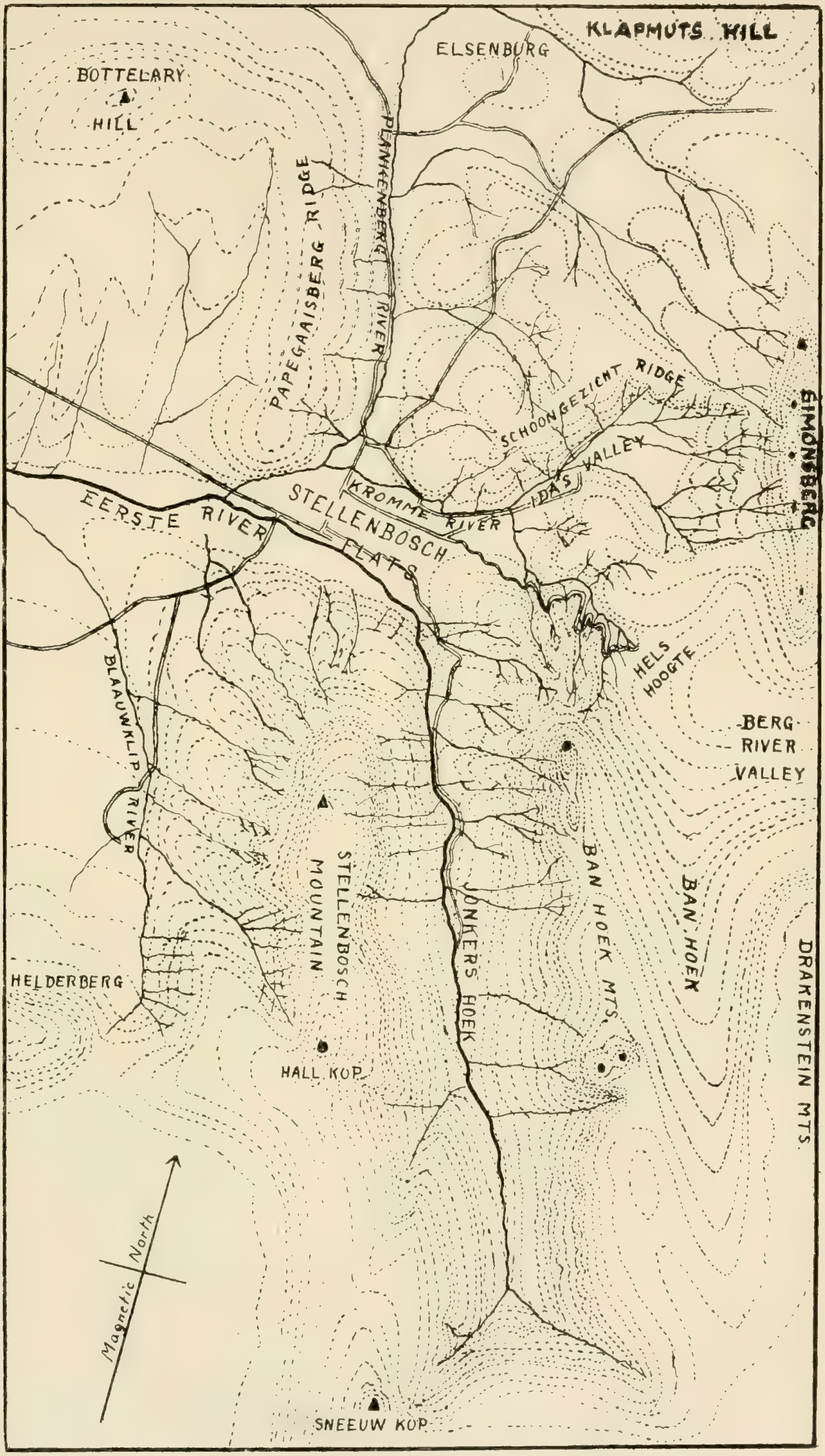
By Professor S. J. Shand.

(*Plates 4-5 and six text figures.*)

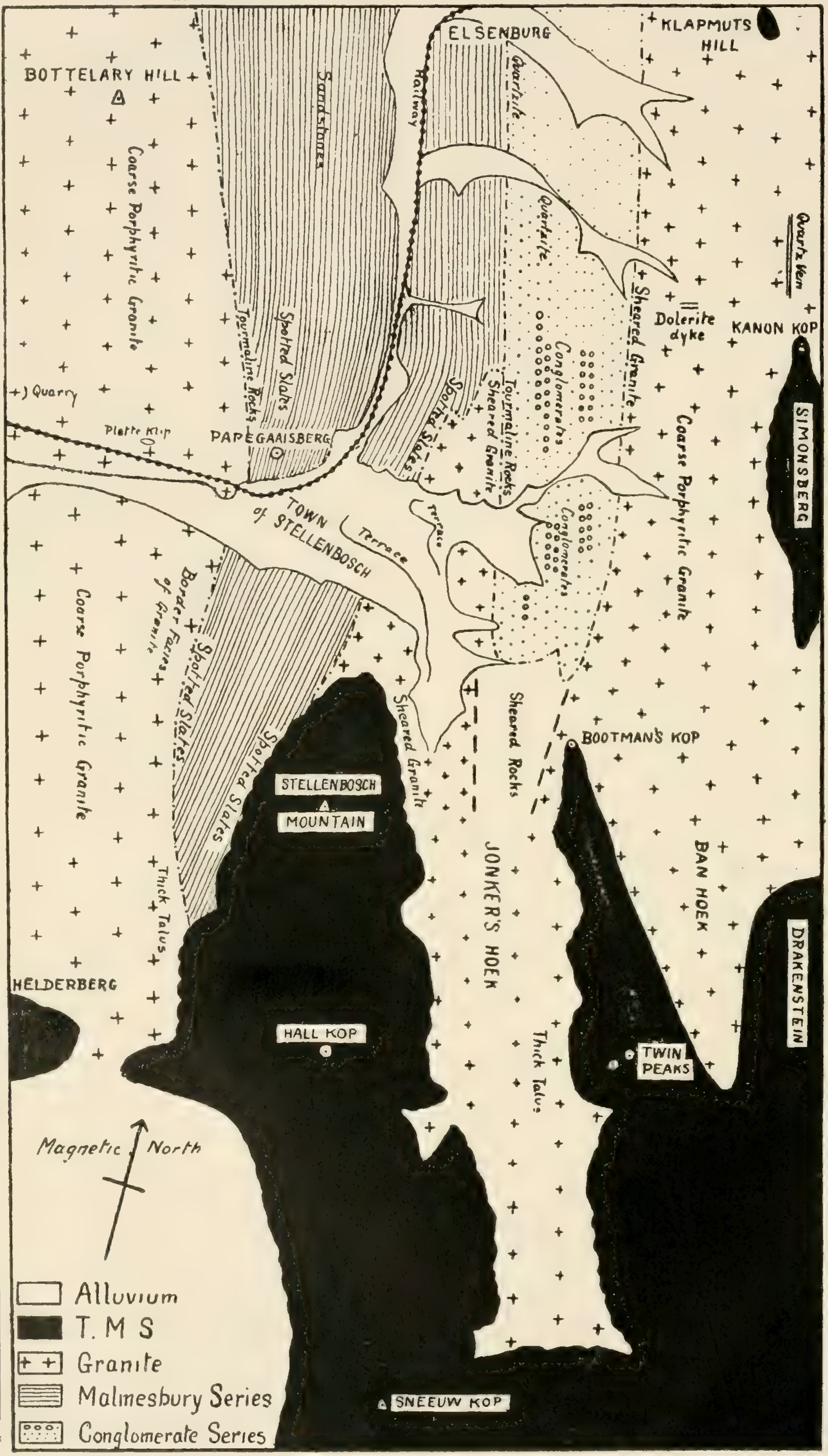
The geology of the Stellenbosch district was discussed very briefly in the First Annual Report of the Geological Commission, published in 1896, and it is depicted on a small scale in Sheet I of the geological map of the Cape of Good Hope. The present occasion seems appropriate for the presentation of the subject in somewhat greater detail, in order that the account may serve as a guide to students of the University of Stellenbosch. The writer has naturally paid much attention to local geology during his six years of residence in Stellenbosch, and has mapped part of the district on a large scale. There are certain points whose interpretation is not yet clear, and which can only be elucidated by further mapping carried beyond the tract of country which we may fairly call "the neighbourhood of Stellenbosch." Nevertheless, it should be possible, and it will perhaps be useful, to submit a fuller account of the geology of our neighbourhood than has yet appeared, laying stress on what is known and indicating what is still obscure.

Five geological formations lie under our feet or heaped up in the mountains which surround us. One of these consists of the steeply tilted slates and sandstones, to which the name of the *Malmesbury Series* has been given; these are, perhaps, the oldest rocks exposed in the district. Less well known, because less well exposed, are the greatly disturbed conglomerates and sandstones, which emerge with a north-westerly strike from the mouth of Jonker's Hoek, and continue across Ida's Valley towards Elsenburg. To these rocks Rogers gave the provisional name of the *French Hoek Series*; the determination of their age and their relation to the Malmesbury beds is the foremost geological problem which this district presents. The *granite* masses which penetrate the Malmesbury Series constitute our third formation. Younger than any of these, and found only on the tops of the mountains, for the most part above the 1,000-feet level, is the *Table Mountain Sandstone*; and youngest of all, flooring the valley in which we reside, is the thick *Alluvium* of Eerste River.

The areas where these rocks are exposed, or throughout which they may reasonably be inferred to extend, are indicated on the accompanying map (Plate 5). An unfortunate circumstance, which introduces difficulties into what should otherwise be a very simple piece of geological mapping, is that contacts or junctions between the various formations are almost nowhere exposed to view; and consequently the boundary lines separating



Physiographic Map of the Neighbourhood of Stellenbosch, showing the headwaters of Eerste River and the main roads. Surface relief indicated by sketch contours. Scale ½ inch = 1 mile.



Geological Map of the Neighbourhood of Stellenbosch.
Scale ½ inch = 1 mile.

certain of these formations on the map are only approximately correct.

Before proceeding to describe these geological formations in greater detail, it will be desirable to refer to

The Physiographic Features of the District.

Stellenbosch lies in the narrow belt of foothills which fringe the western escarpment of the Drakenstein Mountains, and which, gradually dying out towards the west, merge into the Coastal Plain or Cape Flats (see map, Plate 4). To the east of us lies the almost sheer wall of the Drakenstein, with its projecting spurs to which we give the names of the Ban Hoek Mountains and the Stellenbosch Mountains, and its island-like outliers Simonsberg (to the north-east) and Helderberg (to the south), which are just the detached ends of similar spurs. The average height of these mountains is well over 3,000 feet, and the following are the heights of some of the more prominent peaks:—

Stellenbosch Mountains (trigonometrical beacon), 3,824 ft.
Sneeuw Kop (trigonometrical beacon), 5,211 ft.
Bootman's Kop, 2,965 ft.
Twin Peaks, Ban Hoek Range, 5,160 ft.
Helderberg (trigonometrical beacon), 3,724 ft.
Simonsberg, summit, 4,770 ft.
Simonsberg, Kanon Kop (trigonometrical beacon), 2,994 ft.

Between the spurs the valleys are narrow and deeply incised. The most noteworthy of them are French Hoek and Ban Hoek, which open out at Drakenstein into the flat-bottomed valley of the Berg River, and Jonker's Hoek, which debouches into the Stellenbosch Valley. Between the valleys of Drakenstein and Stellenbosch the high neck, known as Hels Hoogte, connects Simonsberg with the Ban Hoek Mountains, and forms a divide between the Berg River System, a branch of which, the Dwars River, rises in Ban Hoek, and the Eerste River System. The valleys among the foothills have gentler slopes than those in the hard Table Mountain Sandstone. The largest of them are Ida's Valley, north-east of Stellenbosch, and the valley of the Plankenberg River to the north-west. Between these valleys is the long ridge, which forms the northern boundary of the Stellenbosch Flats; this ridge does not seem to possess any local name, and we may call it the Schoongezicht Ridge, from Mr. Merriman's beautiful farm, which is bounded by it. The wide, flat valley of the Plankenberg River runs in a north-westerly direction to Elsenburg, and is delimited by the Schoongezicht Ridge on one hand, and by the Papegaaisberg Ridge, running from Papegaaisberg up to Bottelary Hill, on the other hand.

The Stellenbosch Valley, bounded on the south by Stellenbosch Mountain, on the east by Hels Hoogte, on the north by the Schoongezicht Ridge, and on the west by the Papegaaisberg Ridge, is shaped something like a starfish. One long arm of the

star reaches south-east into Jonker's Hoek. Another arm points eastward up Hels Hoogte. A third arm is represented by Ida's Valley, coming down from the west flank of Simonsberg; and a fourth is the Plankenberg Valley. The fifth arm of the star-fish is the wide gap by which Eerste River makes its escape to the west. The body of the starfish is formed by the Stellenbosch Flats, and of its arms four are inlets and only one is a water-outlet. Stellenbosch is therefore a *hydrographic junction* of some little importance.

The Development of the Eerste River System.

The course of Eerste River is peculiar: for the first ten miles of its career it runs north-west, then changes its mind at Stellenbosch and turns south-west; south of Faure it again turns abruptly to south-east before it escapes into False Bay. The explanation of this eccentricity demands a mental excursion into remote geological periods, for the birth of the river probably followed close upon the heels of the movements of folding and elevation, which enclosed the Karroo within its girdle of mountains; that is, the initiation of the river may date from late Mesozoic time.

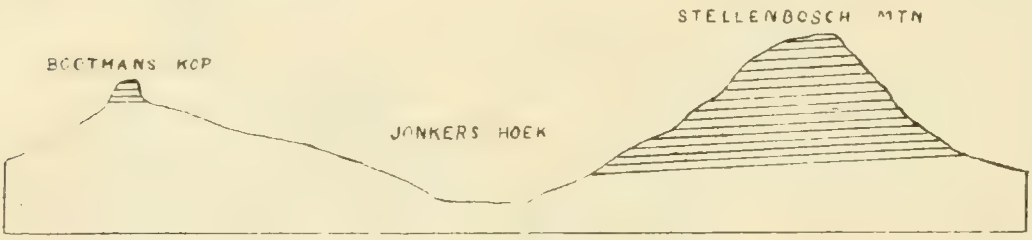


Fig. 1.

Observe that Stellenbosch lies just about the point where the N.-S. folds of the Cedarberg System swing round and become the E.-W. folds of the Langberg System; the strike of the folds is therefore roughly N.W.-S.E. in this part of the country. If Eerste River arose as a consequent stream, its original course must have been roughly S.W., as its middle course still is. Why has it in its upper course assumed a direction at right angles to this? The answer to this question is supplied by the geological structure of Jonker's Hoek. Stand on the Flats and look towards the mouth of the Hoek. On your right hand is Stellenbosch Mountain, on the left Bootman's Kop; each of them the end of one of the spurs which enclose the Hoek. The two mountains have a similar architecture, each of them being composed of a pyramid of Table Mountain Sandstone resting upon a base of granite and old, tilted sediments. The lowest krantz which you can see on the mountain-side marks the base of the Sandstone: follow this horizon from west to east. On the west side of Stellenbosch Mountain it lies some 1,320 feet above sea-level; on the east side, on account of the gentle north-eastward inclination of the beds, it has declined to about 1,050 feet. Crossing the valley to Bootman's Kop, the same horizon is found at an elevation of 2,550 feet (see Fig. 1). Go up Jonker's Hoek,

and you will find the Table Mountain Sandstone descending on the west side ever nearer and nearer to the river, while on the east side it hangs high up in the air. Here we are clearly on the line of a fault, or it may be a monoclinal fold, along which the rocks on the west side have been dropped down some 1,500 feet.

For further evidence, if any is required, of the existence of a powerful dislocation along the line of Jonker's Hoek, one need only look at any of the small rock exposures in or about the mouth of the valley. The granite has been sheared and crushed along vertical planes with a N.W.-S.E. direction, and it is now quite streaky in appearance; the sedimentary rocks of the French Hoek Series have suffered the same change to such an extent that it is now very hard to recognize their original character; among them there occur bands of coarse conglomerate in which the pebbles have been compressed and elongated. Whether the

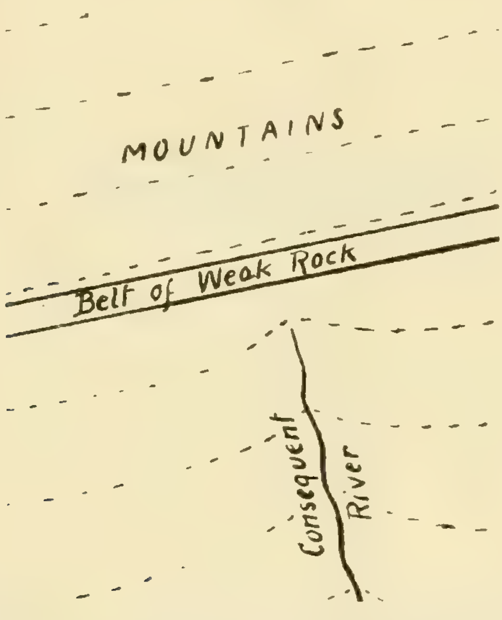


Fig. 2.

dislocation is to be called a fault or a monoclinal fold is a matter of little importance: it is probable that there are many parallel small faults rather than one great fault. Nevertheless, we shall not be violating any convention if we speak of the Jonker's Hoek Fault, meaning thereby the whole aggregation of parallel faults and shear-planes.

It is a matter of common observation that lines of fault are lines of relatively easy erosion; hence the reason which immediately suggests itself for the direction of the upper portion of Eerste River is that the river *discovered and followed the line of weakness made by the Jonker's Hoek Fault.* We may suppose the original consequent stream, with its S.W. direction, to have cut its way back into the mountain mass of which Simonsberg and the Stellenbosch and Ban Hoek Mountains are the remnants, and eventually to have reached the line of fault

which crossed the backward prolongation of its course (see Figs. 2, 3, 4). It then developed a "subsequent" tributary along this line of least resistance, which, cutting down rapidly, in the course of time gouged out Jonker's Hoek. Strictly speaking, therefore, the stream which comes out of Jonker's Hoek is a tributary of the older stream, whose true headwaters arise on Hels Hoogte. Owing to more favourable geological conditions, however, the subsequent has acquired greater importance than the headwaters of the consequent. Seen from this new point of view, the apparently eccentric behaviour of what we call Eerste River is explained: the middle and lower portions have roughly their proper consequent direction, but the upper third has developed from a subsequent, and therefore meets the main trunk at a high angle.

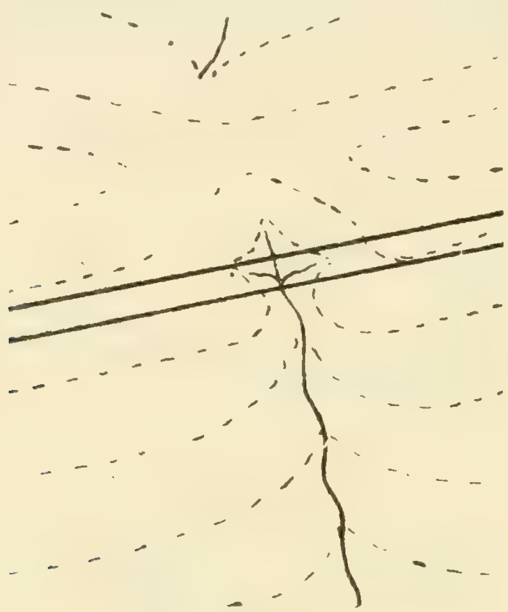


Fig. 3.

The eastward bend of Eerste River just before it flows into False Bay is a much younger development than the above: it has been produced by the building of a bar or storm beach across the mouth of the stream, which was therefore compelled to seek a new outlet.

From consideration of the Eerste River System, we may turn now to that of its principal deposit.

The Alluvium of Eerste River.

This deposit, which forms the flat floor of the Stellenbosch Valley, consists of boulders, sand and silt with a distinct stratification. Good sections of the deposit may be seen in the banks of Eerste River itself, just below The Home; also among the sand pits at the east end of the golf course, and in the banks of Kromme River in front of Mr. Garlick's farm, Glenelly. The total thickness of the deposit does not seem to have been proved anywhere, which is surprising in view of the activity of

prospectors throughout the district, and the possibility that the lowest beds may hold alluvial tin.

I have spoken of the valley bottom as being flat: as a matter of fact, the alluvial floor is disposed in three well-marked terraces, having the average elevations of 10, 18, and 45 feet respectively above present river level. The highest terrace is found in the north-east corner of the Flats, where its margin forms a prominent gravel ridge (see map, Plate 5). The second terrace forms the central portion of the Flats, and its margin can be traced from the mouth of Jonker's Hoek down to the Football Ground, running nearly parallel to the Jonker's Hoek Road and Van Riebeek Street. The third terrace constitutes the remaining, southern and western parts of the Flats: beneath this terrace the river has entrenched itself to a depth of 20 feet in places.

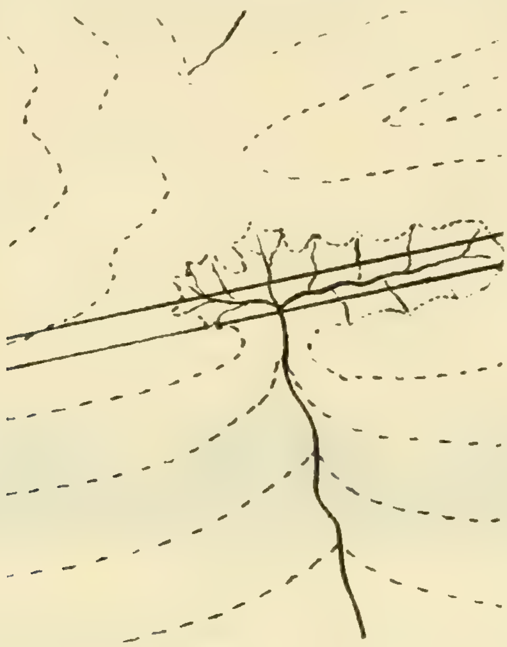


Fig. 4.

Elsewhere* I have described these terraces at some length, and have tried to picture the conditions which led to the accumulation of a thick deposit of alluvium at this point in the course of the river, and to the subsequent step-by-step removal of this material with production of a terraced structure in the residue. Briefly, the conclusions to which I was led are these: That the formation of a deposit is to be ascribed to the confluence at one spot of a number of torrential streams, all throwing their burdens of sediment into Eerste River, and perhaps also to the abrupt change of direction suffered by the river between the points where it enters and leaves the Flats; and that the subsequent partial removal of the deposit was induced by a general elevation of this part of the country, whereby the gradient, and hence the transporting power of the river were increased, and

* "The Terraces of Eerste River at Stellenbosch." *Trans. Geol. Soc of S.Afr.*, **16** (1913), 147.

it was enabled to remove some of the material which it had formerly deposited.

The evidence of the terraces alone could hardly be accepted as conclusive proof of elevation of the country, but it is confirmed by the existence of raised beaches and wave-cut terraces at Sea Point (to the west), at Gordon's Bay (to the south), and at Hermanus (to the south-east). Of these deposits the first and third are well-known. The raised beach at Gordon's Bay is small, and it will probably disappear altogether before long; for this reason, and also because it falls within the limits of the district now being described, a word about it will not be out of place. It is to be found in the south-east angle of the Bay, on the top of the rocky shelf which fringes the southern shore. The deposit is cut through by the road, and little of it is now left, but at the roadside one can still see a few feet of shells and sand—a typical beach deposit now lying some 20 feet above high water mark.

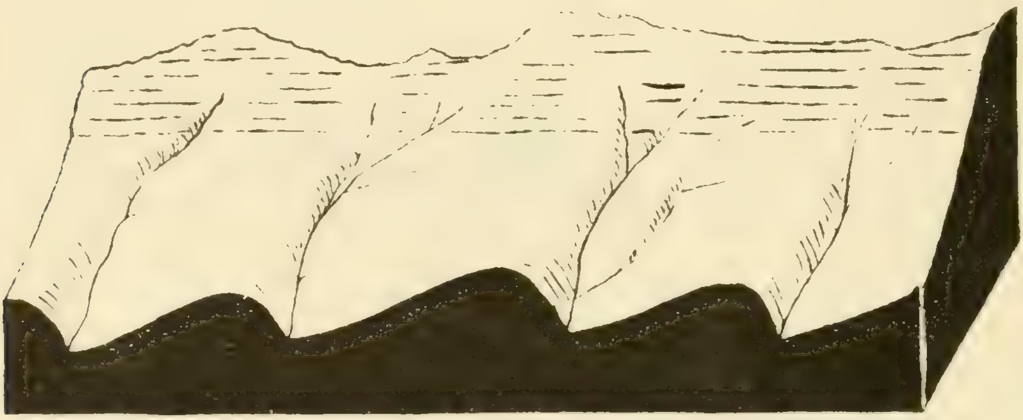


Fig. 5.

Besides these proofs of recent elevation, there is another kind of evidence which points to a recent *tilting* of the country. The south-east and north-west streams, which course down the sides of the Stellenbosch and Ban Hoek Mountains and Simonsberg, have this curious feature common to all of them, that their north banks are much steeper than the south ones. This feature is illustrated in Fig. 5. The meaning of this is unmistakable—it indicates that these streams have been *shifting laterally northwards* as well as cutting downwards. This phenomenon can be seen quite clearly in Jonker's Hoek or from the Helderberg road, and it does not seem explicable save on the hypothesis of tilting.

The Table Mountain Sandstone

forms the rugged capping of all the mountains; it does not differ in any way from the same formation as developed on Table Mountain itself. The lowest visible krantz is always at or very near to the base of the series, and beneath it the slopes are smoothly rounded and covered with talus and vegetation: the

underlying rocks are then either granite or soft sediments of the Malmesbury or French Hoek Series. The actual foundation on which the Sandstone lies can be seen at a few points; thus round the foot of the cliffs on Bootman's Kop the granite appears immediately below the sandstone. The junction of the Table Mountain Series with the eroded surface of the Malmesbury Beds is seldom clearly visible, but in a kloof on the farm Niet-Gegund, on the west side of Stellenbosch Mountain, this unconformable junction is almost completely exposed. A sketch of the junction is given in Fig. 6.

The lowest beds of the Table Mountain Series are often brightly coloured, and contain much argillaceous matter; red and brown shaly sandstones, just like those seen at the base of the Lion's Head, occur in the lower hundred feet of the series on Bootman's Kop. Thin pebble-bands occur all through the series; false-bedding is common, and ripple-marks not unusual.

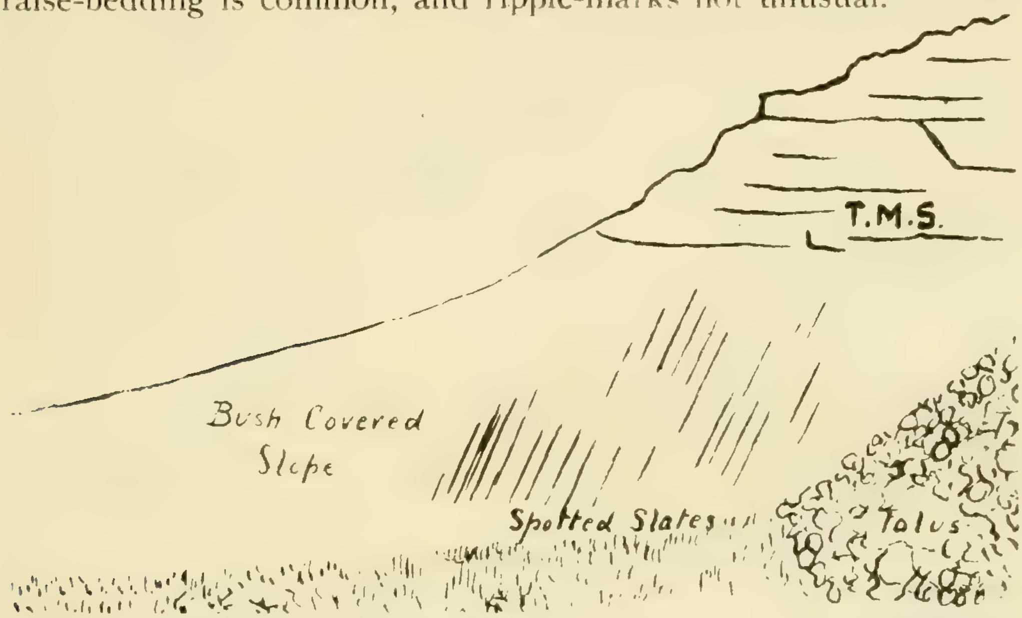


Fig. 6.

The dip of the beds is very low or nearly zero around Stellenbosch. On Stellenbosch Mountain itself there is a very gentle north-east dip, which increases further up Jonker's Hoek. Only a few miles away, however, at French Hoek and Sir Lowry Pass, the folding is already severe.

THE GRANITE

of the neighbourhood occurs in three masses, or, rather, three lobes of what is just one large batholith. There is nothing whatever to indicate that the different lobes were not all intruded at one and the same time.

To the west is the large area of granite which stretches from Bottelary Hill to Somerset West, and from Papegaaisberg, nearly to Kuil's River. The granite is seen immediately one crosses Plankenberg River by the road-bridge at Bosman's Crossing. It is a coarse, porphyritic variety, indistinguishable in

appearance from that of Table Mountain. Black micaceous patches, representing altered slate inclusions, are fairly numerous, and little pockets of black tourmaline are also found. Veins of pegmatite and aplite are common, and some of these run out some little distance into the slate. I have already described the veins and inclusions of this granite mass* and need not refer to them further.

The Malmesbury rocks, hardened and altered by contact to chiastolite-hornfels, are exposed only a short distance up-stream from the bridge, so at this point the granite margin can be fixed with precision. From here the boundary runs in a north-westerly direction towards Bottelary Hill, but it cannot be placed accurately on account of the thick overburden. Papegaaisberg itself, save only the south-west side, and the whole ridge right north to Koelenhof, consist entirely of Malmesbury rocks, showing evidence of contact alteration. South of Papegaaisberg the contact disappears under the alluvium for half-a-mile, after which the granite reappears in a long, low ridge to the west of the Somerset Road. The granite in this ridge is of very variable texture, and in part of rather fine grain, which suggests the close proximity of the contact surface. Malmesbury rocks are not exposed here, however, nor are they to be seen until one climbs up into some of the kloofs which descend from Stellenbosch Mountain. In these kloofs and on the lower slopes of the mountain one gets occasional evidence of the continuation of a belt of Malmesbury rocks along the west side of the mountain as far as the Blaauwklip Stream; beyond this, right into the Hoek of Helderberg, only granite is exposed. The line of junction can therefore be laid down pretty accurately, although it is not actually visible at any point.

This eastern margin of the granite ought to possess an especial interest, since the western margin is highly mineralized at Kuil's River, and yields tinstone, wolfram and arsenopyrite. The abundance of tourmaline veinules in the granite about Bosman's Crossing and at Vlottenberg show that there has been active mineralization on the east side as well as the west. Some veins of arsenical pyrites (according to an analysis by Dr. van der Riet, the actual species is löllingite) occur in the granite on the farm Bonte River, at Helderberg, and molybdenite has also been found there, but no tin. I note, however, as a point of some possible significance, that tourmaline quartzites of identical character occur about the contact on the property of the Good Hope Tin Mines at Kuil's River, and on Papegaaisberg. I have not been able to find the rock in place on Papegaaisberg, but boulders of it are abundant all down the south slope of the hill. The rock is peculiar in appearance, consisting of angular fragments of white quartzite in a dense black base of minute tourmaline needles. I have found boulders of this rock as far to

* "On Veins and Inclusions in the Stellenbosch Granite." *Rept. S.A. Ass. for Adv. of Sc.* Port Elizabeth (1912), 247-251.

the north as the farm Nooitgedacht, so the tourmalinized zone must be pretty extensive. The presence of tourmaline is, of course, no proof of the occurrence of tin, but it gives an encouraging suggestion of it.

The western margin of this granite can be studied conveniently between Lynedoch and Eerste River Stations. The marginal facies is non-porphyritic, and contains many small pockets of tourmaline. Between it and the Malmesbury rocks there is again a tourmaline zone, as is shown by the occurrence of boulders of quite coarse-grained tourmaline quartzite.

With the exceptions of these marginal facies and of the aplite and pegmatite veins already mentioned, the granite hardly varies at all in appearance or composition. It is throughout a coarse, porphyritic biotite-granite with subordinate muscovite, with microcline as the commonest felspar.

The second area of granite is bounded on the west by a line which runs out from the north end of Stellenbosch Mountain. The exact position of this line was determined at two points—one in a drain at the side of the vineyards of Coetsenburg, and the other in the bed of Kromme River, just below the Co-operative Winery buildings. The boundary continues northwards into the Schoongezicht ridge, and is seen again in a kloof north of the farm Cloetesdal, where some small apophyses are thrown out into the slate. The eastern margin of this granite tongue is hard to place, but the imperfect exposures on the top and round the base of the ridge and on the Hels Hoogte road indicate an approximately straight line running S.S.E. (magnetic) into Jonker's Hoek. The granite of this mass is on the west side identical with that of Bosman's Crossing, but in Jonker's Hoek and opposite the mouth of the Hoek it has been strongly sheared, and has, in consequence, become streaky, with cataclastic structures. This shearing and destruction have affected not only the granite, but also the French Hoek sediments to the east of it, and on account of this and also of the inadequate nature of the exposures the eastern margin of the granite cannot be placed with precision.

About the northern end or apex of this mass, on the top of the Schoongezicht ridge, boulders of cherty quartzite, containing tourmaline, are to be found, indicating again a mineralized contact zone.

Near the top of the Hels Hoogte road, after traversing the French Hoek beds at right angles to their strike, one meets again an unsheared porphyritic granite, the margin of which runs northwards towards Schoongezicht and southwards into Jonker's Hoek. This, the third lobe of the batholith, is continuous eastward to Drakenstein, and northwards towards Paarl: southwards it forms the floor of Ban Hoek and Jonker's Hoek, and eventually disappears beneath the Table Mountain Sandstone. The fresh rock has precisely the same characters as the unsheared granite of the other lobes; the western margin has been affected by shearing movements along the Jonker's Hoek fault.

There is little doubt that the second and third lobes coalesce in Jonker's Hoek; and the trend of the margins of the first and second lobes (see the map) makes it certain that these, too, unite under Stellenbosch Mountain. The three lobes therefore represent one single intrusion.

Dolerite Intrusions.

Many dolerite dykes cut the granite in some districts, notably the Cape Peninsula and Somerset West. In the more immediate neighbourhood of Stellenbosch I have only located one, on the farm Muratie, near the north end of Simonsberg. This dyke is many yards wide, but its margins are covered, so the exact width could not be ascertained; it cuts coarse porphyritic granite. It is more interesting than dolerite dykes usually are, on account of the presence in it of a quantity of xenocrysts of quartz and felspar derived from the granite. The rock is light grey, of decimillimetre grain, and contains white spots up to a centimetre in diameter, which appear to be felspars derived from the granite. Besides plagioclase and augite the rock contains brown biotite and some interstitial quartz. The felspars are rather unfresh, and their optical characters cannot be very satisfactorily determined. The white spots are altered felspars, filled with decomposition-products; their irregular shapes point to their being xenocrysts, not phenocrysts. The larger fragments of quartz are, without any doubt, xenocrysts; each is completely surrounded by a shell of augite crystals, a phenomenon which has been observed in other cases of reaction between a magma and its xenocrysts. Taken all together, these features suggest that there has been an appreciable amount of solution of granite by the doleritic magma.

The Malmesbury Series

is represented in the immediate neighbourhood of Stellenbosch by a long tongue of slates and argillaceous sandstones, which has been caught in between the western and central lobes of the granite batholith. These rocks decompose so easily that they are generally hidden under a thick overburden, and it is hard to form an idea of the normal composition of the series. On the other side of the western granite mass, however, good sections of the Malmesbury beds are exposed in railway cuttings between Lynedoch and Eerste River stations, and these sections may be taken to be representative of the series. Just beyond the granite margin, some two miles past Lynedoch station, there appear in a cutting dark brown clayey rocks, dipping vertically and striking about magnetic north. They are very rotten, but show spots of chiastolite, and are clearly decomposed shaly rocks. They are cut by some interesting dykes of aplo-pegmatite, and by quartz-tourmaline and pure quartz veins. Further away the rocks are fresher, and are best described as very cleavable argillaceous sandstones, spotted by metamorphism, with occa-

sional beds of hard brown quartzite, and here and there banded cherty layers. The sandstones show distinct false-bedding and split easily along the main bedding-planes, and two sets of vertical joints. Further towards Eerste River Station the outcrops are of hard blue hornfels, without prominent bedding or joints, with chiastolite spots which are most readily seen on cross fractures. There are no beds in the whole succession that are really entitled to be called slate, and few that are unequivocally sandstone, and the original deposit seems to have consisted of sandy clays and fine clayey sandstones without any coarser deposits whatever

Similar facies of the Malmesbury rocks can be seen on the Stellenbosch side of the granite mass. The blue spotted hornfels appears in the river bed on the south-east side of Papegaaisberg. The brown, spotted sandstones are seen in poor exposures here and there on the top of the Papegaaisberg ridge, and on the northern slopes of Stellenbosch Mountain. Spotted rocks, which we may call slates, although they lack true slaty cleavage, appear in the kloofs on the west side of Stellenbosch Mountain, and boulders of spotted hornfels and sandstone occur generally along all the contact zones and help one to trace these on the surface. The dip of the beds, where they can be seen in place, is always more than 60°, and the strike is roughly parallel to the eastern margin of the series as laid down on the accompanying geological map (Plate 5).

The tourmalinized rocks of the contact zones have already been mentioned. It is not quite clear whether they belong to the Malmesbury series or are to be regarded as the altered margin of the granite itself.

The French Hoek Series.

The winding road which climbs from the Flats up to Hels Hoogte begins and finishes its ascent in granite, but on the way it cuts through a series of very decomposed and crushed sedimentary rocks, which strike about 10° west of magnetic north. These rocks, as well as the granite for some distance on either side of them, have been caught and crushed in the zone of the Jonker's Hoek Fault. For the greater part the rocks are slates or phyllites, and they possess a well-developed cleavage, which coincides with the stratification. Some beds, however, are sheared grits or arkoses, and there is at least one band of greatly crushed conglomerate with elongated and flattened pebbles. On the hill tops north of the Hels Hoogte road, and again on the top of the Schoongezicht ridge, conglomerates and grits reappear, and they are well exposed in a deep kloof on the farm Onrust, and again on Knor Hoek. The pebbles are often several inches in diameter, and some have been flattened into discs, while others have been elongated. Slicing these for the microscope gives one little assistance in identifying the pebbles, because the material is crowded with decomposition-products. Some of the pebbles,

however, can be recognized as fine-grained sandstones, quartzites, and vein quartz, and a few contain quartz grains in a dense base, and may be decomposed quartz-porphyries. On the whole, the difficulty of studying these rocks is due more to weathering and inadequate exposures than to crushing.

These beds were included by Rogers in his French Hoek Series, and he suggests their correlation with the Ibiquas or Upper Nama beds. Their relation to the Malmesbury beds is, in this neighbourhood at least, not clearly ascertainable. It will be seen from the geological map that the central lobe of the granite mass has Malmesbury beds on one side, French Hoek beds on the other. Where this tongue of granite dies out the two must come into contact. Just at that point, unfortunately, all useful exposures cease, and one can only presume that the strike of the Malmesbury beds swings round and becomes parallel to that of the French Hoek beds. This is certainly the case in the Malmesbury series a couple of miles to the west, on the top of the Papegaaisberg ridge. There is no clear indication of unconformity between the two series, but, on the other hand, it would not be permissible definitely to assert their conformity: the point must remain open for the present. Personally, I think the two series are conformable, or that the unconformity, if it exists, is only a slight one like that between the Malmesbury and the Ibiquas. I have already pointed out that a tourmalinized contact zone exists on the east side of the granite tongue, towards the French Hoek beds, and (although no French Hoek rocks are exposed along the contact) this points to the granite being intrusive towards the latter. For this reason it would, perhaps, be more satisfactory to compare our conglomerate series with the Nieuwerust or Lower Nama than with the Ibiquas or Upper Nama, for the latter is younger than the granites intrusive in the Malmesbury Series. Further than this, the evidence available in the neighbourhood of Stellenbosch does not enable one to go.

SOUTH AFRICAN GEOGRAPHICAL SOCIETY.—It was resolved, at what is reported to have been a large and representative meeting held in the School of Mines, Johannesburg, on the 8th June, to establish a South African Geographical Society. The chair was occupied by Principal G. S. Corstorphine, B.Sc., Ph.D., and an address on "Geography, its Field and its Future," was given by Mr. J. Hutcheon, M.A., F.R.S.G.S. In the course of his remarks Mr. Hutcheon explained that the objects of the proposed Society would be to raise the standard and safeguard the interests of the subject and those teaching it, to encourage geographical research in all its branches, and to arouse in the general public more enthusiasm therein. In time the Society would, it was hoped, grant a diploma of fellowship. It has been arranged to hold a series of popular lectures in connection with the newly formed institution.

AN INTERESTING CASE OF INSECT MUTUALISM.

By Rev. Nendick Abraham, F.R.M.S.

By the term "mutualism" as distinct from "commensalism" or "parasitism," we mean such cases where two distinct and unrelated creatures are found constantly in close association without any cost or loss to either, though in some cases there may be some gain to one of the partners derived by the connection.

I will now set forth a case of mutualism which came under my notice while living in Durban, Natal. One of the partners is deserving of some special attention for its own sake, and though its habits are generally well known, I will refer to them, as I have had opportunities for careful observations. The insect belongs to the family Cercopidæ, and is one of the "frog-hoppers" or "spittle bugs," and is known to entomologists as *Ptyclus flavescens*. There are several well-known species of frog-hoppers in this country, such as *Aphrophora grossa*, common in peach trees. The insect I am to deal with is perhaps the largest of the family, measuring over an inch in length. It is found in Natal and neighbouring parts of this country. In common with other members related to it, it does not pass through a complete metamorphosis. The only striking difference, apart from size, between its infant and adult condition is that in the latter it has acquired two pairs of wings. In its grub or nymph stage the insect covers itself with a quantity of froth, which quite hides the creature from sight. This froth is obtained and manufactured in the following manner. The mouth-parts of the frog-hoppers are fashioned into a long, sharp beak, which is thrust into tender shoots of plants or soft bark of trees, and is employed in sucking up the sap. If one of the grubs be removed from its covering of froth and placed on a clear place on a twig of the tree, it will be noticed that the beak will presently be made to pierce the bark, and the sucking operation commenced. In a short time there will be a discharge of clear fluid from the posterior end of the body, which will soon flow under and over it. After the lapse of a little time the creature will commence an active movement of its abdomen, or the hinder segments of it. The movement is up and down, and from side to side. With each downward stroke it carries into the fluid a minute portion of air, which becomes entangled by the viscosity of the fluid, and so forms a tiny bubble. A continuation of the movements soon turns the fluid into a quantity of froth, which completely covers the nymph. The sucking process continues, and in the case before us such a surplus of fluid passes through the body of the insects that it freely drops from the tree, as though some secret power caused the tree to drip rain. This fact is the origin of the fabled "rain-trees," which someone proposed should be planted in desert places to make up for the absence of rainfall. The truth is strange enough without the need of exaggeration, as the following observations will prove.

One day I was making a round of visits, and left the carriage with my native boy while I made a call. It was a very hot afternoon, such as are common in Durban (Natal) in summer. On my return to the road, after my visit, I found the boy had thoughtfully moved the carriage some distance along to take advantage of the shade of a large "flat crown" tree. The boy was standing at the horse's head half asleep. On reaching the carriage, I found an interesting condition of affairs. The tree had been "weeping" in consequence of several parties of frog-hoppers inhabiting the branches. The cushions, splash-boards, and floor of the conveyance were so wet that there had to be a general clean-up before I could go on my way. A tree in the Parsonage grounds began one day to "weep." Wishing to make some observations, I set a vessel upon the ground where drops were falling. As the tree was a high one, and the drops had to fall from a considerable height, and the wind sometimes swayed the branch, all the drops did not fall into the receptacle, but after several hours I poured out the liquid which had been caught, and found that it measured a full quart; the liquid was as clear as water, and of course consisted of the sap of the tree, which had passed through the bodies of the insects. The small amount of nutritive matter dissolved in the sap had been retained in the bodies of the frog-hoppers, and the clear liquid, slightly viscid, had been expelled. Five or six dozen of these sap-suckers will fill a quart vessel in an hour and a half. The most wonderful example I have as yet met with, as to the quantity of liquid shed from a single company or batch of frog-hoppers, came under my notice one very hot summer in Durban. Out walking one day, I noticed a tree "weeping." The tree is known as a "flat crown" (*Albizzia fastigiata*). One branch of this tree overhung the road. The ground had a gentle slope, so that when the liquid fell it was possible, if it fell in sufficient quantities, to saturate the dry, hard, hot ground and then trickle down the incline. Now, although evaporation was being carried on to a great extent owing to the heat of the sun, the sap shed from the tree, after passing through the bodies of the sap-suckers, had saturated the ground and had made the road so soft that the wheels of passing carts had churned up a miniature swamp, or mud-patch, some five feet wide, with sap standing like water after rain in the depressions made by the cart-wheels. Nor was this all, for the sap was making its way down the incline of the road just as a tiny spring of water would do. I visited this tree two days after I had found it, and took with me my camera and tape measure. I took two good pictures, which I still have in my records, and measured the "swamp." In its broadest part it was five feet, and in a narrow course down the road it extended thirty-five feet. Considering the dryness of the surrounding ground and the heat of the sun, I was surprised at the quantity of sap which must have been pumped out of that one branch of the tree. The froth manufactured by these insects is no doubt to some extent a protection

to them from their enemies, but it is certainly a protection to their soft bodies from the heat of the sun—a heat which these nymphs could not survive except for the constant supply of moisture which bathes their bodies and keeps them cool and moist. As soon as the grub or nymph is ready to change into the perfect insect it leaves the froth, which soon dries up, changes its skin for the last time, comes into the possession of fully-developed wings, and moves off to enjoy a larger life. The adult insect is a little more than an inch in length. Its upper wings, which are leathery in texture, are coloured yellow with a few black spots or marks, but the colour and markings vary in the same species.

But now I must mention the fact which justifies the heading or title of this paper. On making a careful examination of a batch of grubs covered with their froth, I noticed a number of small maggot-like grubs, white in colour, and about one-eighth of an inch in length, moving quickly over the moist bodies of the large froth-bearers. The froth had to be removed with a brush before these creatures could be seen. Their bodies were very soft and delicate, and they seemed to be absolutely dependent upon the froth secreted by their huge companions for their safety and existence. But for the protecting froth the hot sun would soon have dried them into dust. Sheltered in this screen of bubbles they found nutriment and protection from birds, etc., but especially from the rays of the sun. But what becomes of these little grubs, which are in no sense parasitic upon the frog-hoppers, but only mutuals? When their companions mature and fly away there will be no protecting froth. What then? So soon as the large insects are ready to leave their larval state, or before that time, these tiny "guests" are also ready to be independent of their protection. They pass into the chrysalis stage, and fix to the bark of the tree by a secretion-like varnish their tiny cocoons, which look like minute buds belonging to the twig. These cocoons form ample protection to the life within, and after a short time development takes place, and from the cocoons emerge minute flies, which do not appear to be in any way related to the parasitic flies which abound in this country. Owing to the loss of material I have not, however, identified these flies, but hope to do so when I get another opportunity. I wish I could tell how the larvæ of the little fly are introduced to the frog-hoppers. Probably the parent flies are attracted to the patches of froth and deposit their eggs therein, but this is a point which needs to be observed. There can be no doubt that the minute "guests" are entirely dependent for their existence on the hospitality of the frog-hoppers. It must also be noted that the period necessary for the development of the larvæ of the flies must be sufficiently brief to enable them to complete the change into the pupæ before their hosts leave the larval stage. If this were not so, they would perish. Taking these points into consideration, we have, I think, a case of mutualism worthy of note and consideration.

I may add that a few years ago Mr. S. L. Hinde came across some of these large frog-hoppers in British East Africa, which not only produced the mimic showers, but also in a very remarkable way mimicked flowers. With their wings closed, these adult insects cluster round the narrow leaves of the trees, the tips of their closed wings touching the leaf, and the head slightly away from it. In this position the group presents much the appearance of a branch of broom in flower.

(*Read, July* 6, 1917.)

Theories of Cosmogony.—Until the beginning of the present century the nebular hypothesis of Laplace held a unique position as a tentative explanation of the origin of planetary systems. The hypothesis had, it is true, been forced to undergo many changes of detail, but its essential doctrine, that increasing rotation was the primary cause of the birth of satellites, remained almost undisputed. In recent years the position of this hypothesis has been challenged by speculations based ultimately upon the conception of tidal forces providing the required tendency to separation, the most complete and definite of these speculations being found in the planetesimal hypothesis of Moulton and Chamberlain. Mr. J. H. Jeans, M.A., F.R.S., recently read before the Royal Astronomical Society a paper embodying the results of his mathematical investigation of the changes in a mass of matter as the tidal forces acting on it continually increase. The paper is published in the Society's *Memoirs*,* and in it the writer discusses the tenability of the tidal theory of planetary evolution, arriving at the following conclusions. The normal binary star formation cannot be explained as the result of tidal action; the genesis of such systems must be ascribed to rotation. In regard to spiral nebulæ, however, there are certain features which can be explained in terms of tidal action, but on the whole it seems impossible to reconcile this explanation with the known facts of astronomy. The genesis of our own solar system may well be attributed to tidal action, for the theory makes no impossible or improbable demand here: at the same time, the origin which seems most probable is not that of the planetesimal hypothesis.

* **71** [1], 1-48.

PARALLAX OF THE FAINT PROPER MOTION STAR NEAR ALPHA OF CENTAURUS. (PRELIMINARY ANNOUNCEMENT.)

By R. T. A. Innes, F.R.A.S., F.R.S.E.

The discovery with the blink-microscope of a star of the 10th magnitude (1900, R.A., 12h. 22m. 55s., Dec., 62° 15′.2) with a large proper motion was announced in Circular No. 30 of the Union Observatory. As this faint star is moving across the sky in much the same direction and with much the same angular motion as α Centaurus, it was at once guessed that its distance from the sun would also be of the same order, which means that it would be one of the nearest stars to our system.

The first determination of its proper motion and the proper motion of α Centaurus compared as follows:

Faint Star	4″.9	towards	289°
α Centaurus	3.68	,,	281

but this first determination was not very secure, and the suggestion that its proper motion was identical with that of α Centaurus was hazarded.

Observations to determine its parallax were started at the Union Observatory by myself, and at the Cape Observatory by Mr. Voûte. My series will not be completed until the end of August. Nevertheless, a weak and incomplete determination may be of interest. So far, the Johannesburg observations yield a proper motion of 3″.9 a year, and a parallax of 0″.80. It will be seen that the proper motion is practically equal to that of α Centaurus, whilst its parallax is somewhat larger (α Centaurus 0″.75, Gill). Within the limits of error there is the chance that the parallaxes are also identical. In any case the accordance in both proper motion and parallax is sufficient to allow us to say that the faint star is a member of the α Centaurus system, and that it is perhaps the nearest star to our system.

In astronomical units (the mean distance of the Earth from the sun) this star is roughly about 6,000 units distant from α Centaurus and 250,000 units from the sun. Its light-emission is of the order of 1/10,000 that of the sun.

(*Read, July* 3, 1917.)

ON THE EFFECT OF VEGETATION ON THE RAINFALL OF SOUTH AFRICA.

By H. Pealing, M.Sc.

This is a subject which has been hotly debated. On the one hand a vast mass of evidence has been put forward that large tracts in South Africa are drying up, pointing to a diminishing rainfall; on the other hand, it is maintained that the moisture which is precipitated in South Africa comes from the Atlantic and Indian Oceans, and is propelled there by forces which operate outside the continent, and at great distances from it, and therefore on an average the rainfall must remain invariable from decade to decade.*

The writer proposes to examine a little more closely the latter statement. The evidence regarding the desiccation of many large tracts of South Africa is so overwhelming that few dispute the fact.

South Africa may be divided into three rainfall areas—

(*a*) The winter rainfall area.
(*b*) The all-the-year-round rainfall area.
(*c*) The summer rainfall area.

The last area is the most important, and includes Natal, the Transvaal, etc.

The source of supply for the rainfall for this area is the Indian Ocean. The winter rainfall is derived chiefly from the Atlantic Ocean.

The writer hopes to shew that the amount of the summer rainfall in a district far from the coast is dependent to a large extent on the character and quantity of the vegetation of the intervening country.

The rain gauge is used to ascertain the amount of the rainfall. This instrument is at best a crude one, and many circumstances make its readings unreliable. The first difficulty with regard to the rain gauge is that of location. It is usual to place a rain gauge three to six feet from the ground, and at some distance from trees and other sources of obstruction. When this procedure is adopted the readings are disturbed and rendered unreliable because of the presence of eddies-circling round the instrument which are produced by the wind, which usually has a high velocity when rain is falling. These eddies give a corresponding motion to the raindrops falling into them, and these drops consequently receive an outward deflecting motion, and many which would otherwise fall into the rain gauge fall outside of it. The following experiment, an account of which is contained in Milham's "Meteorology," will make this clear: Two similar rain gauges were taken; one was placed in the open three feet above the level of the ground, and the other was placed about 200 feet above the ground as much in the open air as possible. It was found "that the lower rain gauge caught nearly twice as

* Erosion and Rainfall: Senate Committee's Conclusion. 1914.

much as the more elevated one. Now, if the rain gauge was a perfectly accurate measurer of rainfall, you would expect the upper gauge to register slightly more than the lower gauge, as the drops get slightly less in size as they fall because of evaporation, and the level of rain-bearing clouds is quite high, even in winter. In fact, we should expect the amount of rainfall to increase with elevation till the level of the rain-bearing clouds was reached.

In the above experiment, the reason for the discrepancy is to to be found in the increase in wind velocity with elevation. This increases rapidly as you rise from the ground.

Now there is another circumstance besides the height of the rain gauge above the ground, which would influence its readings, and that is the character of the rainfall. Large raindrops would not be deflected very much by the eddies, because in the first place they fall through the eddies quicker than smaller drops, and in the second place they expose less surface in proportion to their weight than the smaller drops, to be acted on by the eddies. The rain gauge, on this account, would have very little error in registering the heavy rainfall, but would considerably underestimate the drizzling, soaking rains. An extreme case is that of snow: here the average density is very small, and it is impossible to valuate the amount of the snowfall by means of the rain gauge:

For these reasons the writer rejects the rain gauge as an instrument for determining whether the amount of rainfall in South Africa has been undergoing an alteration—as the character of the rainfall has undoubtedly altered over large tracts of the country—a large portion of the rainfall being torrential downpours where formerly gentle soaking rains were the rule.

If we except the Western Province, all portions of South Africa have a considerable proportion of rainfall in summer. Since the rainfall of the Western Province has not altered in character during historical times, this portion will not be considered at all in this communication.

In summer the region in Central Africa at the equator, and just south of it, is enormously heated, and a convectional rise of the air there takes place on an enormous scale, and heavy rainfall occurs in consequence. This convection and the large humidity causes the pressure to be very low there, and consequently air rushes from the south, where the pressure is much greater, to take its place. Owing to the rotation of the earth, this air is deflected towards the west, and forms the south-east trade wind. Unfortunately for South Africa, the relative humidity of this wind is not very high. The inland plateau of South Africa is unduly heated in summer, and consequently the wind, when forced to rise when leaving the ocean to enter it, does not have its temperature lowered perceptibly, consequently, as a general rule, no moisture is precipitated.

The temperature of the inland plateau is probably warmer than the moisture-laden air which starts from the Indian Ocean,

so that, unless this air goes up very quickly, it will arrive in a state of considerable dryness.

The rainfall there must be due to another cause, and that is the considerable convectional rise we get there particularly late in summer. Now, according to its latitude, the inland plateau ought to be a region of descending currents of air, and a very dry region such as the horse latitudes. There are two reasons why that should not be the case in South Africa. In the first place, the belts of high pressure at the horse latitudes are comparatively shallow, and at an altitude of 4,000 feet have disappeared entirely, so that at altitudes above that height the pressure there is lower than that at higher latitudes at the same height. The second reason, which is only operative in summer, is the undue heating of the inland plateau, which causes a convectional rise, and therefore a reduction in the pressure. That is, monsoonal conditions are established. We may say that generally the rainfall of the inland plateau is due to a convectional rise there. Let us examine what the consequences of this will be. When the air rises it cools at the rate of about 1.6° F. for a rise of 300 feet if no heat is lost by radiation and if there is no condensation. Consequently, if air continues to rise, a point will be reached when its moisture will condense in the form of a cloud.

To calculate the height at which the cloud would appear, supposing the rise of the air to continue, you would need to know the temperature of the air when it commenced to rise and its dew-point then. The temperature at which the cloud condenses is not, of course, that dew-point, because the water vapour is also expanded by a convectional rise. The approximate formula meteorologists use is: substract the difference between the temperature of the air at the earth's surface and the dew-point there, and multiply by 300 and divide by 1.27.

When air is caused to rise by convection, it ceases to rise as soon as its temperature has been lowered to that of the surrounding air. As soon as that temperature is reached its vertical velocity is zero, and it spreads out laterally. It is easy to see that if the dew-point is comparatively low—that is, if the air is comparatively dry to begin with—the whole convectional circulation will take place below the cloud-forming level, and consequently will give rise to no precipitation. If the convection current should reach the cloud level, then moisture will be condensed, and in consequence of this the convection will be further promoted, because—(*a*) the cloud will absorb the radiant heat falling on it from both the sun and the earth, and this will raise its temperature; (*b*) the latent heat is liberated on condensation, and if the freezing-point is reached, further latent heat is liberated.

It is easy to see that if the convection once reaches the cloud level, it will, as a rule, go much higher. In the case of a thunder cloud it may reach a height of four or five miles. The

writer is of the opinion that the vegetation of a country has a very considerable effect on the number, extent, and intensity of thunderstorms in summer. In the first place, it should be clearly realized that vegetation puts a very considerable amount of moisture into the atmosphere. It has been calculated that an area covered with vegetation puts 25 per cent. more moisture into the atmosphere than a free water surface in the same conditions of wind velocity and temperature. Much depends on the amount of vegetation and on the kind of vegetation.

Forest trees give an enormous amount, so much so that trees are often planted to dry up marshy districts, which defy every other means. Now let us consider the case of the inland plateau of South Africa. The air which reaches there, travelling from the ocean, must go over fairly large tracts of territory, some from the north, some from the south-east. If this surrounding tract of territory is very arid, then this air will gain in temperature, but not in moisture content; consequently it will only be in exceptional circumstances that you will get a convectional rise sufficient to give rain. If, on the other hand, the surrounding tract is well covered with vegetation, then the air going over it will not be so much heated, because the temperature of the land will be less, and, what is more important, it will gain a considerable amount of moisture, but not necessarily an increase in relative humidity. When the inland plateau is reached, the causes which give rise to convection need only be present to a feeble extent to produce rain, consequently we should expect that the number of rainy days would be increased, and this is confirmed by experience. Now it is the universal experience that the rainfall is greatest near the coasts, which first receive the wind, and that it gradually decreases as you go inland. The effect of a country well covered with vegetation is to make the decrease very gradual in deed—that is to say, to bring oceanic conditions much nearer to inland places.

Consider the regions suitable for forest growth. The presence of forests allows the land to absorb readily the rainfall which falls on it, and prevent the rapid run off to the sea almost as soon as it has fallen. The forests afterwards slowly transpire the moisture in the air, whence it is carried inland, as a general rule, by the prevailing wind, and may again be precipitated as rain there.

In conclusion, the writer urges that all suitable areas should be planted with trees, and that the wholesale denudation of the land, whether of trees, bush, or grass, should be discouraged as much as possible. This policy would enable the forest districts to make use of what rainfall they had, and to confer at the same time a benefit to those inland. Not only would those inland get a larger rainfall, it would come in a much more useful manner, and would be more evenly distributed over the rainy season.

(*Read, July* 5, 1917.)

AN OLD REPORT ON THE COPPER FIELD OF NAMAQUALAND.

By Arthur William Rogers, M.A., Sc.D., F.G.S.

When I was enquiring for early accounts of the copper-bearing region of Namaqualand, Mr. Graham Botha, Keeper of the Archives in Capetown, showed me the report which is printed below. This report, of which there are three copies bound in "Attestatien," Vol. 1 (1688-1698), was written by Friederich Mathias van Werlinckhof, who went to Namaqualand with Simon van der Stel in 1685. It may be the first report on a mining venture ever written in South Africa.

Van der Stel's journal of the expedition does not mention van Werlinckhof by name, but he is presumably the man referred to by van der Stel as "de berghopman." He was a passing visitor at the Cape, and nothing further about him is known to me.

The spot where prospecting was begun, "aan de Witteboomen, drie uiren van t' Fort," is evidently the place on the Peninsula still known as "Silver Mine."

When the expedition reached Namaqualand, work was started on a ridge formed by a dyke of diorite and norite in the gneiss five miles east of the present village of Springbok. The ridge is called Koper Berg to-day, but in spite of much prospecting during the past 60 years it has not yet been found to contain a payable mine. A spot on the ridge has "1685" cut in it in old-fashioned characters, and it is said that van der Stel's initials were there until some vandal obliterated them by cutting his own on the place where they used to be. This spot is apparently the place called "H. V. R." in the Report.

There is, in the Library of the South African Museum, a most interesting book of water-colour drawings of plants and animals, done by someone connected with the expedition, and on the first page of the book there are two sketches of scenery on the copper field, one of which is a view of the Koper Berg with van der Stel's camp in the foreground, and the other represents a spot which I have not yet been able to identify.*

*I have to thank Dr. W. F. Purcell for showing me this book. It has the title "Plantæ et Animalia in Promontorio Bonæ Spei Africes ad naturam delineata et colorata Ao 1692, in usum cons. Amsteled., nec non Rerum Orientalium. Directoris Nicolai Witsen"; and it is inscribed "Dit Werk is voor mij aan de Kaap gemaakt, N. Witsen, 1692."

The frontispiece is thus described: "A. A. Dit is de Coperberg, door den E. Heer Commandeur Simon van der Stel, den 21 Octob: 1685, ondect, en ruij 10 mijlen verre personelijk gevisiteert, en doorgaens een gank en ader die von onder uijt den grond op, tot den top van den berg klimt, en ten minsten van 8 tot 9 voeten, dog merendeels van 2 â 3 roede breedte ganschelijk van een coleur, en met Spaans-groen uijtgeslagen bevonden. H. V. R. Een berg gansch en geheel uijt Copertz, van boven tot beneden toe, bevonden, dierhalven aldaer wel 18 voeten diep gegraven, en hand over hand rijcker mineral ten voorschijn gekomen is."

The mention of silver is difficult to understand; so far as I know, that metal has only once been recorded amongst those (copper, gold, lead, antimony, molybdenum, iron and arsenic) found in the fields; and it is said, by A. Knop, to occur in fahlerz (tetrahedrite). The word "missive," which I have translated "pure metal," may perhaps be correctly so translated, for native copper has been found in the surface rock of several mines in the district, but more probably it refers to the metallic-looking sulphides, bornite and chalcopyrite.

Attestatien, 1686—1698.

Alsoo de Heeren Majoris in 't vaderlant mij Ondergesg, als Berghhopman hebben aangestelt niet alleen omme op de West Cust van Sumatra de opzight op de Bergh Werken te nemen, maar ook in 't passeren alhier an Cabo d' boa Esperanes te doen een nauwkeierige Inquisitie naar soodanige mineralen, als haar Ed er Hoog Acht bericht is geworden in dies gewesten te resideren, soo hebbe ter Ordre van Hoog Ed-b geb-n Heer van Mijdreght, 't redirt sijn aanwesen alhier, exactelijck besightigt alle wateren, kleijne rivieren en bergen, hier in 't District om de Caap op ettelijcke mijlen gelegen, doch hebbende alhier ten gerinsten niet connen vinden eenige metale of mineralen van gout of silver, dan alleen een plaatse aan de Witteboomen, Drie Uiren van 't Fort gelegen alwaar om de bequaamheijt van sijne situatie ende abondantie van hout en water, een kleijn werck tot een proef met de geringhste hende cleenste oncosten die mij bedenkelijk sijn geweest begonnen heb, met ongewaar 10 man, daar onder drie met mij hier aangelant, mitsgaders 7 slaven mij op mijn versoek door den Ed. Heer Commandeur toegevoeght: zijnde drie mijne reeds geadvanceert tot up sestien vadem diepte, alwaar sij bereids eenige goede Inditien ende kentekenen van mineralen openbaren, alsoo den Ents van dien enigh coper dogh seer weijnig silver is—houdens, sijnde bovendien gemelte Mijnen

There are further references to details in the sketch, but the above are the most interesting, and they may be translated thus: "A. A. This is the Copper Mountain discovered by His Excellency, Commander Simon van der Stel, on October 21st, 1685, and explored by him personally for some 10 miles; and generally there is a dyke or vein which rises from below and reaches the top of the mountain; it is at least 8 to 9 feet wide, and for the most part it is 2 to 3 roods wide; it is all one colour, and is distinguished by its Spanish green mottling. H. V. R. A hill found to be entirely made of copper-ore from top to bottom; at this place, therefore, a pit quite 18 feet deep was dug, and continuously richer mineral came to sight."

The legend of the second sketch is: "Een vlacte omtrent drie mijlen Noordwaarts van den Coperberg gelegen, in't midden van dewelke een vlacke horizontale klip men gevonden heeft, uijt welkers poren of gaetjes, 't Spaans-groen gelijksaam uitborreld en te voorschijn komt." ("A flat place about three miles north of the Copper Mountain, in the middle of it was found a flat rock, from the pores or holes of which Spanish green oozes out and appears more or less uniformly.")

Mr. Lloyd, Librarian of the S.A. Public Library, has shown me a somewhat similar book in his keeping, but a sketch of the hills in it is less interesting than that of Koper Berg described above.

niet subject om van eenigh water te connen werden belemmert alsoo de naast aangelegen diepte van den bergh meer als 80 vadem nederschiet, sijnde vervolgens seer apparent dat selfst in den regentijt gemelte meijn door 't water niet veel sal g'incommodeert werden.

De goede gelegentheijt van welcke meijn, mij geobligeert heeft in 't arbeijden te continuerden omme als zijnde een niuw werck to onderstaan wat voordelen sigh onder de hant moghten comen te openbarde, sullens mede enige Ente tot U Ed Hoogacht laten afgaan omme naar genomen preuve van de apparentie van dien des te bequamer te mogen oordelen. Verders alsoo meergemelte Ho Ed H van Mijdreght den E H Commandeur hadde geauthoriseert een Landtoght te doen omme te onderstaan wat voordelen in dese gewesten omtrent 't ontdecken van eenige mineralen voor de Ed Compi mogten komen te resideren, ende mij bij die gelegentheijt aan bevolen hadde den E. H. Commandeur in 't visiteren des op te doene mineralen te adorateren ende mijne gevoelen daar omtrent op 't papier te bringen ten obedientie van welcke ordres ende bevelen soo hebben niet willen naarlaten gemelte landtoght nevens sijn E. te onderstaan, gelijck dan op den 25st Augustig des afgeweken jaars 1685, van de Caap de Goedehoop vertrocken sijn ende na ongevaar een maand reijsens de Oliphants Rivier gepasseert sijnde, soo heeft den E Heer Commandeur van die plaats af tot aan de Buffels revier toe, soodanig als 't daregister breder sal komen uittewijsen sigh nevens mij onophoudelijk ende seer nauw keurig g'informeert op de gelegentheijt den geberghten, de selve seer exactelijck besightigende of oock eenige mineralen mogten geven, ende op in t' passende bevonden hebben diverse mineralen dogh als decxels van andere hooft-mineralen, de nogh niet fiex zijnde geen velcomentheijd ofte vaste adren hadde, ende namals de E. H. Commandeur op alle rustplaatsen door sijne bijhebbende Berghwerckens de gelegentheijt van die oorden, seer nauwhebbende doen inspecteren en niet van merite opgedaan hebbende, het niet raadsaam was, dat E. H. Commandeur, sigh aan diese bergen van geen meerde apparentie schijnende langer ophield, ende genegen om sijne reijse tot voldoeninge van sijne E Oogwit naar den kooper Bergh voort te setten, eensdeels om geen gebreck van water op onse te rugh reijs te hebben, ende anderdeels om de goede apparentie daar van sign E. oordeelde gemelte Cooperbergh te zijn nemende eghter verscheijde preuven den gepasseerde bergh mineralen mede, omme de selve aan de H. Majores tot een proef in 't vaderlant overtezenden, op dat haar E. H. Achtb van de deieght van dien selver ende met te beter kennisse zouden konnen oordeelen en welcken Coperbergh wij eijndelijck naar veel moeijelijckheden en sieckelens gecomen zijnde, soo heeft de E. H. Commandeur benevens alle gelegentheden van dien met grooten ijver en moeijte nauwkeurigh ondersoght, ende de bequaamste plaatsen afgesien ende uijtgekosen hebbende, hebben wij ons wercke tot ondersoek der mineralen begonnen in 't werck te stellen ende eerstelijk op

sulke plaats die de H. Command-r de Naam gaf van H.V.R. alwaar in 't Arbeijden bevonden hebben coper mineraal mit Missive ingesprenckt, ende ter selve plaatsen nederdalende tot op 3 vademen bevonden de selve hoe dieper hoe beter te zijn, houdende de selve mineralen goet silver soodanigh als de proeven van dien komen uijt te wijsen, soe dat mijne oordeels seecker ende evident is, dat gemelte meijne hoe daar dieper in sal komen nedertedalen rijcke en rijcker mineralen sal komen uijtteleveren te meer om dat het buijten alle twijssel is, dat de mineralia in den beginne noijt volcomen sijn, ende hoe dieper leggen hoe oock vaster solider ende rijcker bevonden werden, een musquet schoot van en ter zijden welcke meijn den E. H. Commandeur met mijn advijs weder hebbende doen arbeijden, ende aldaar een niuwe proef of anderhalf vadem gedaan hebben, soo hebben bevonden die plaats zijnde aan en bequamen oort gelegen mede uittelevern koper en silver van selvige soort als boven, dogh wat rijcker van mineraal gelijk van Metaal, soo als uit de proeven komt te blijken, ende wiert dese plaatse doen den E. H. Commandeur genaamt met de naam S.M. sijnde dese plaats van soo goede apparentie volgens de gedane proeven dat niet anders connen oordeelen of sal in 't arbeijden, ende als men daar in wat dieper sal nedergedaalt sijn, dat niet alleen seer goede mineralen maar wellightlijk pur massive koper moghten komen uijtteleveren, te meer dewijl 't begin van 't werck sigh ten eenemaal daar toe schikt.

Wederom een of twee musquet schooten aan de anderzijden van gemelte eerste mijne de E. Heer Commandeur ten derdemaalen doende arbeijden, hebben aldaar bevonden die meijne mede te houden mineraal van de selve soorte als boven, ende daar in nedergedaalt zijnde tot op 3 ellen hebben geremarqueert de selve van gelijke deightsaamheijt te zijn als de 2 bovengenoemde, mede naar uijtwijs van de proeven daar van gemaackt, ende wiert dese laatstegenaamt met de naam van S.V.S. omme de goede constitutie van welcke mijnde ick absoluijt van gevoelen ben, dat indien men het bergwerck daar aan komt voort te setten de mineralen van tijd tot tijd rijcker ende beter sullen bevonden werden, geconsideert den gemelten Bergh sigh in lenghte en breete tot op ettelijke mijlen is uijtstreckende en meest alle plaatsen mineraal houdt. als mede op sommige overvloedig van water voor menschen en beesten versien is, gelijk sulx benevens den E. H. Commandeur in 't besightige persoonlijk bevonden heb. Zijnde verders dien ganschen landstreecke doorgaans beset met sout en sulphur, een seker kenteken 't selve in mineraal en rijk is, gelijk ook volgens getuijgenis van alle experte Bergwerckers vast gestelt word, dat alle mineralen door de natuirlijke warmte ende 2 voorsz; specien sout en sulphur werden gegenereert ende gecoaguleert, verders alhier aan Cabo d' Boa Esperance niet voorgevallen zijnde 't geen mijne kunst ende Wetenschap concerneert, soo verklare dit bovenstaande te sijn mijn rapport ende wedervaren, gedaan in 't Casteel de Goede Hoop den 18 Maart 1686.

(Sijnd.) Friederich Mathias van Werlinckhof

Translation.

The Directors at home appointed me Chief Mining Engineer, not only to take over the supervision of mining operations on the West Coast of Sumatra, but also, in passing the Cape of Good Hope, to make close enquiry into such minerals as the Governor has reports of as existing in this region. There were also the instructions of the Lord of Mydrecht, given when he was here, to report precisely on all waters, streams and hills in the district within a few miles of the Cape. However, not the least trace of gold or silver could be found here; at one place only, near the Witteboomen, three hours from the Fort, where, on account of the convenience of its situation and abundance of wood and water, small operations were commenced as a test at the least possible expense, with about ten men, three of whom I brought with me from home, together with seven slaves supplied at my request by the Commander. The mine was already sixteen fathoms deep, where there were some good indications of minerals exposed. These contained copper and a very little silver. Moreover, the above mine is not likely to be hindered by water, as a kloof near by has a depth of more than 80 fathoms; this clearly shows that even in the rainy season the mine will not be inconvenienced by water. The favourable conditions at this mine induced me to continue the work, it being a new venture, so that I could judge what profit might be anticipated; I will send your Excellency some samples, in order that from the results of tests you may form a better judgment.

Further, the said Lord of Mydrecht authorised the Commander to make a journey in order to ascertain what profit could be found in the country in the way of minerals before the Honourable Company takes it over, and he authorised me to assist the Commander in exploring the minerals, and to give my opinion in writing in obedience to those orders.

So, being unwilling to delay the said expedition with the Commander, we left the Cape of Good Hope on 25th August last year, 1685, and, after about a month's journey, crossed the Oliphant's River; from that place to the Buffel's River, as will appear in more detail in the diary, the Commander was all the time fully informed by me of the nature of the rocks, which were closely examined to see if they held minerals, and on the way various minerals were found capping other minerals, which were, however, neither good nor pure, nor were they in distinct veins. Thereafter the Commander prospected at all the resting-places and examined closely into the possibilities of the localities, but nothing of value resulted. It was not advisable for the Commander to delay further amongst these hills, which gave no apparent indications, as he intended to push forward and reach his aim in the Copper Mountains, in the first place in order to avoid scarcity of water on the return journey, and secondly, after forming an opinion on the Copper Mountains, to take back with him actual and various proofs of the minerals in the country passed through, so that they could be tested by the

Directors at home. In order that the Commander might get better knowledge of the Copper Mountains, we eventually reached them after much trouble and delay. The Commander, with great zeal, and taking advantage of all the circumstances, investigated closely a part of the region, and choosing the best places, we began to work on the spot for the search for minerals, especially at a certain spot named by the Commander H.V.R., where in working we found copper ore with pure metal disseminated through it. At this place we sunk to a depth of three fathoms, finding better ore the deeper we went, holding the same minerals and real silver so far as tests could be made, so that, in my opinion, it is certain and obvious that the deeper one goes the richer and richer the minerals will be, the more so because the fact is beyond all dispute that the minerals first found were not perfect, but the deeper they lay, the harder, more compact, and richer they were found to be. A gunshot to one side of this mine the Commander had further work done by my advice, and here a new trial a fathom and a half deep was made; we found that the spot was a favourable one, and from it were produced copper and silver of the same kind as described above, yet it was richer in mineral and metal, as appeared from the tests; this place was designated S.M. by the Commander. According to the trials made, this place is of such promising appearance that no other opinion can be held than that in working there the deeper one were to sink, not alone very good minerals, but probably pure massive copper, would be obtained, the more so since the work has progressed more and more favourably from its commencement.

Again, at one or two gunshots' distance on the other side of the said mine, the Commander had a third trial made, and there found a mine holding minerals of the same kind as before, and after sinking three ells, we noticed the same good indications as in the two above-mentioned places, according to the trend of the evidence got there; this last spot was indicated by the name S.V.S. I am entirely convinced of the favourable character of these mines; in the event of mining operations being continued, richer and richer, and better. minerals will be found, for the hills concerned extend several miles in length and breadth, and hold minerals almost everywhere. and in some places water for man and beast is plentiful, as the Commander found on personal inspection.

Further, salt and sulphur are distributed through the whole region, a certain indication that it is rich in minerals; and it is also firmly settled, on the evidence of all expert mining men, that all minerals are regenerated and coagulated from the aforesaid salt and sulphur by means of natural heat. Further, it cannot be that here at the Cape of Good Hope there are no mines of interest in the arts and sciences.

I declare the above to be my report and experience, at the Castle of the Cape of Good Hope, this 18th day of March, 1686.

FRIEDERICH MATHIAS VAN WERLINCKHOF.

In conclusion, I wish to thank Mr. Botha for help in copying the original, and Mr. T. B. Herold for correcting some passages which I had not clearly understood.

(*Read, July* 4, 1917.)

TRANSACTIONS OF SOCIETIES.

South African Institute of Engineers.—Saturday, June 30th: B. Price, M.I.E.E., A.M.I.C.E., Past President, in the chair.—"*Notes on the support of the underground workings in the mines of the Rand*": P. **Cazalet.** Methods of work, which have been suitable in the past for the support of hanging walls, are so no longer on many mines, (1) because the workings of adjoining mines are practically assuming the character of continuous excavations, at most only partially supported over long distances, and (2) on account of the increasing depth of the workings. Sand-filling had been introduced with the greatest benefit, but on a large scale only in a few mines, and that sand-filling alone will suffice is unlikely. Four methods of supporting hanging wall therefore remain, viz., (1) the packing or stowage of waste rock, (2) the square set method of timbering, (3) the use of round timber for props, stalls, and pigstyes, (4) the packing of ore actually broken at stope faces. The last method is, in the author's experience, the only one which entirely meets the requirements.—"*Systematic packing underground at the Ferreira Deep Mine*": G. **Hildick-Smith** and R. **Selby.** The nature of the hanging wall, originally a naturally strong quartzite, had completely changed throughout the mine, and had become very broken and dangerous, causing stopes to cave and shafts to give trouble. The mine had been saved by resorting to systematic packing, in conjunction with the removal of pillars, which were replaced by packs. The various methods of packing found to be most efficient were described and illustrated.

Saturday, July 14th: G. M. Clark, M.A., A.M.I.C.E., President, in the chair.—"*Suction gas production from South African bituminous coals*": F C. **Sturrock.** and E. J. **Way.** The authors gave an account of some of their experiences met with, and some of the results obtained in the practical application of South African fuels to one of the latest gas producers of the suction type. Some of the principal difficulties that have had to be overcome in connection with different makes of bituminous plants were discussed, and the improvements which their experience had suggested to the authors were referred to — "*Notes on tests of timber pig styes*": H. C. **Hilton.** In the Transvaal gold mines the natural pillar has to a large extent been displaced by timber stopes in the form of pigstyes,, and the latter, if unfilled, appear inefficient, (1) because of the small proportion of the timber that is called upon to withstand any strain, and (2) because those parts which take the strain carry it in the direction in which timber is weakest. The tests described by the author were made in order to ascertain the correctness of these assumptions, and the most efficient form of pigstye.

Saturday, 11th August: G. M. Clark, M.A., A.M.I.C.E., President, in the chair.—Presidential Address: G. M. **Clark.** The address dealt largely with the subject of education as it affects engineers. Technical education was specially referred to, and free education in the higher stages, as well as in the lower, advocated. The relationships and functions of an Institution of Engineers were also shortly discussed.—"*Further notes on the collapse and recovery of the Central Shaft at the Bantjes Consolidated Mines.*" G. **Hildick-Smith.** A description of the methods used in reclaiming three compartments of a collapsed shaft, with statements of costs.

THE PLANT SUCCESSION IN THE THORN VELD.

By Prof. John William Bews, M.A., D.Sc.

(*Plates 6-9 and two text figures.*)

Introduction.

Tree Steppe or Tree Veld (grass-land with scattered trees) is one of the most extensive, if not the most extensive, of the types of vegetation in the whole Continent of Africa. The species composing it vary in different regions, dependent on differences, chiefly in climate, but partly also and more locally in differences in soil conditions. Practically all the dry river-valleys on the eastern side of South Africa are filled with Tree Veld, in which species of acacia are dominant. The Protea Veld is more of a mountainous type, and extends through Rhodesia. In Rhodesia, also, there are many other types, such as Baobab Veld, with the baobab (*Adansonia digitata*) dominant. The Bush Veld of the Transvaal is a combretaceous-leguminous type with *Terminalia, Combretum, Burkea,* etc. The mopane (*Copaifera mopane*) is dominant in much of the Tree Veld of Angola and South-Central Africa, while Baobab Veld extends right up to the Congo. Practically the whole of South-Central Africa is Tree Veld, interrupted only by patches of eastern forest on the slopes of the mountains of the eastern side. In the tropics, the great Congo forest and the belt of dense forest which extends through the Cameroons, along West Africa, to Liberia, covers a very extensive area, but north of this and south of the Sahara we again get Tree Steppe very similar to that occurring in South and South-Central Africa. In many parts of the tropics and sub-tropics, various palms (*Hyphæne ventricosa, H. thebaica,* or dum palm, *Borassus flabellifer,* etc.) are dominant in Tree Veld.

It will be seen, therefore, that any study of the development of such a type as the Thorn Veld must have a very wide importance. The area studied in detail was the Thorn Veld in the vicinity of Pietermaritzburg, especially the district around Bisley and Foxhill. In the neighbourhood of a town, the influence of man must always be reckoned with, to a more than usual extent. It is now some 70 or 80 years since Pietermaritzburg was founded, and at first for many years the thorn trees of the Thorn Veld were the chief source of firewood, being much more accessible than the forest trees in the Bush. This led to extensive destruction of timber, and great areas were denuded of trees. In the last 20 years, however, wattle cultivation on an extensive scale has been undertaken to the north of the town. After the bark of the wattle tree is stripped, the wood is sold largely as firewood, and this supply has taken the place of the thorn-trees. The Thorn Veld, therefore, is again extending, and that fairly

rapidly, and excellent opportunities for studying the succession are afforded.

Type of Grassland Invaded.

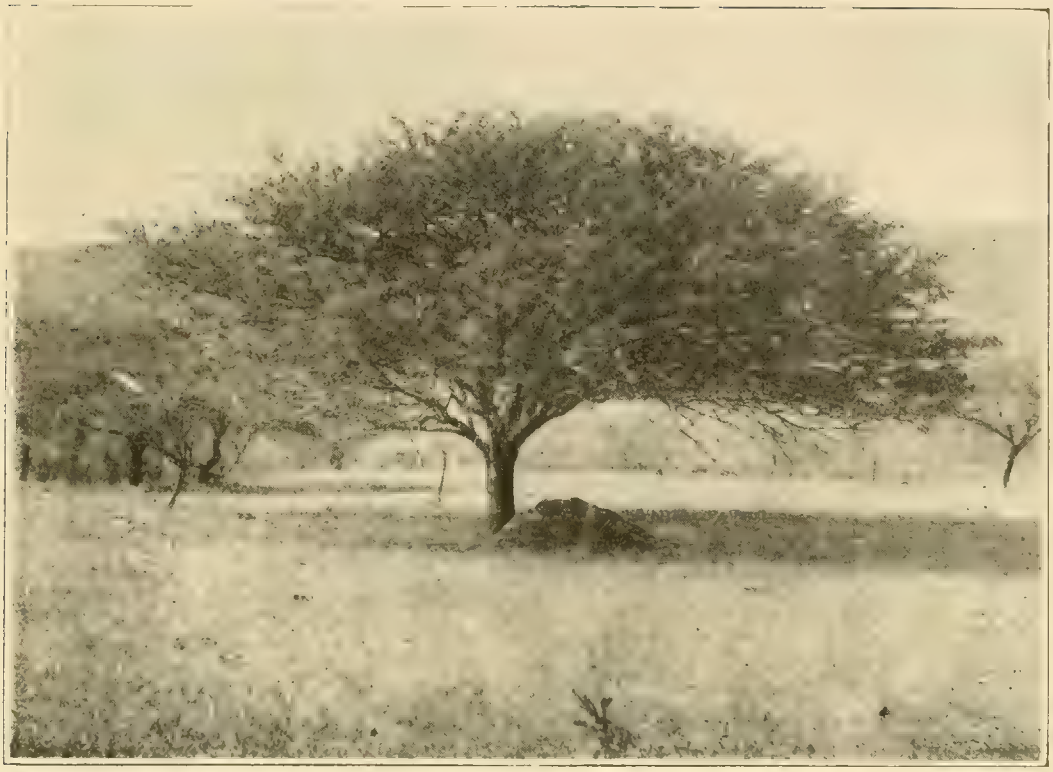
The soil varies within certain limits. It is mostly of the hard-baked type, badly aerated, but rich in chemical salts. The iron it contains exists as the protoxide (FeO). About a foot below the surface ironstone gravel (limonite) is frequent, and nodules of an impure magnesian limestone. There is a certain amount of organic matter in the soil, more than in the High-Veld soils, consequently it is dark in colour. In places it is shallow, but the numerous dongas (see Plate 6 *b*) show that it often reaches a depth of several feet, and below the soil the shale is often loose and broken. Where the veld is unchanged, the Low-Veld variety of *Anthistiria imberbis* is completely dominant, but there is usually a considerable admixture of other species of grasses—*Andropogon hirtus, A. schoenanthus,* var. *versicolor, A. amplectens, A. pertusus, A. auctus,* A. *schirensis, A. plurinodis, A. appendiculatus, Aristida angustata, A. junciformis, Eragrostis curvula, E. chalcantha, E. brizoides, Cynodon dactylon, Tristachya leucothrix, Sporobolus indicus, Chloris petræa, C. pycnothrix, Imperata arundinacea, Panicum spp., Digitaria spp., Eleusine indica.*

Scattered through the grasses there are numerous associated plants, of which the commonest are:—*Dicoma argyrophylla, Corchorus asplenifolius, Hypoxis latifolia, Abutilon sonneritianum, Sida longipes, Hermannia sp., Mahernia grandistipula, Lasiosiphon linifolius, Crotalaria distans, C. globifera,* and other species, *Indigofera spp., Leucas martinicensis, Ocimum sp., Oldenlandia (Hedyotis) amatymbica, Acalypha sp., Lactuca capensis, Helichrysum spp., Asclepias spp., Gazanea longiscapa, Aloe saponaria, Scilla spp.* There are, of course, a great many others; a complete list would run to several hundred. Grass fires and grazing by stock have a great effect on this veld, the general tendency being for the *Anthistiria* to give way to other species of grasses, such as *Sporobolus indicus.*

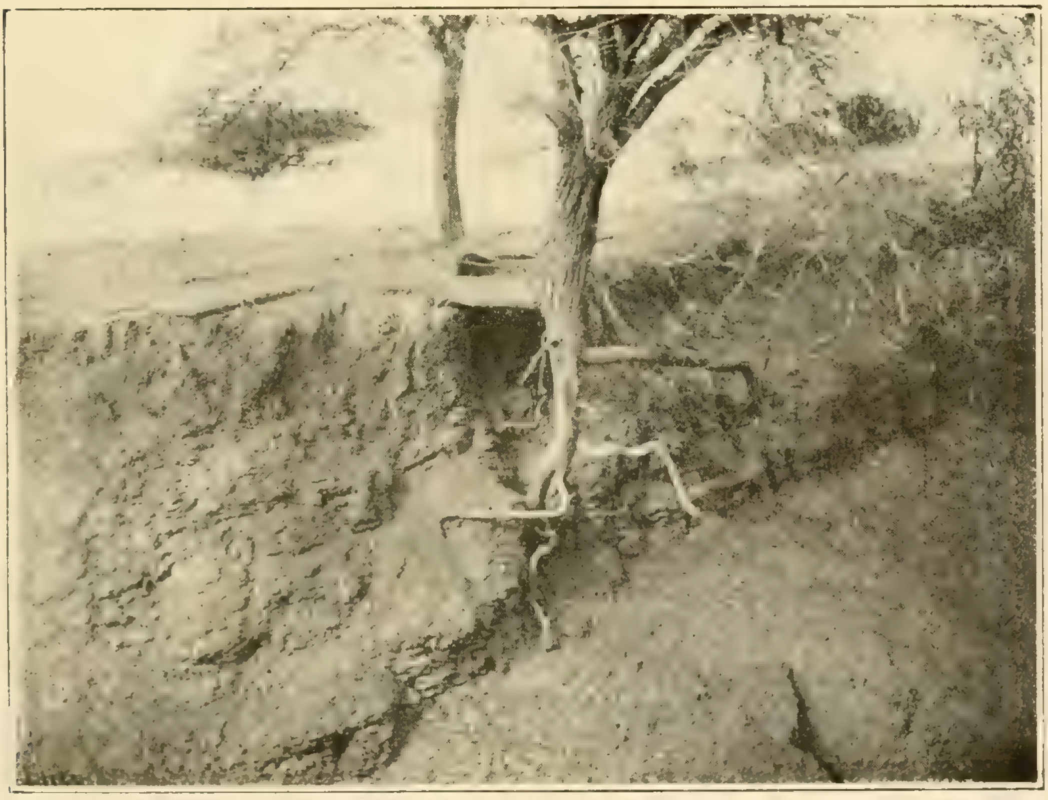
Bases of Colonization.

The banks of the streams and the numerous deep ravines serve as bases of colonization for the numerous species which, given an opportunity, invade the veld. In such sheltered situations grass fires have little effect, nor, owing to their inaccessability, are they much disturbed by man. The various animals, including birds, which act as agents of distribution, congregate in such places, so that seeds are brought from a distance, and in new areas of grassland tree-growth is first established in the ravines.

Good historical evidence from the residents near Bisley proves that, 20 or 30 years ago, the thorn-trees in this neighbourhood were confined to the bottom of the valley near the stream.



(*a*). *Acacia arabica* var. *kraussiana* growing near nest of *Termes trinervius.*



(*b*). Donga showing root system of *Acacia arabica* var. *kraussiana.*

At the present time, the stream-bank and ravine vegetation at Bisley is made up of the following species, named roughly in the order of their abundance:—*Acacia arabica, var. kraussiana, Celastrus buxifolius, Hippobromus alata, Ehretia hottentotica, Jasminum multipartitum, Jasminum sp.* (*gerrardi?*) *Elæodendron æthiopicum, Zizyphus mucronata, Grewia caffra, Acacia caffra, A. horrida, Randia rudis, Xanthoxylon capense, Combretum kraussii, C. salicifolia, Nuxia oppositifolia, Royena pallens, Pavetta lanceolata, P. sp.* (*obovata?*), *Cussonia spicata, Helinus ovata, Gymnosporia* (*Celastrus*) *spp., Brachylæna discolor, Dovyalis* (*Aberia*) *tristis, Azima tetracantha, Euclea undulata, E. lanceolata, Calpurnia sp., Rhus,* two or three species.

Climbing over these we have various lianes, of which the woody *Dalbergia obovata* may be mentioned first. Species of *Vitis* (*Cissus*) are also common—(*Vitis cuneifolia, V. cirrhosa*). *Clematis bracchiata, Asparagus sp., Dalechampia capensis,* and the succulent *Sarcostemma viminalis* also occur. The undergrowth is rich in herbaceous forms—*e.g., Sanseviera thyrsiflora, Lippia asperifolia, Barleria obtusa, Scilla sp., Rubus rigidus, Vernonia corymbosa, Melasma sp., Kalanchoe rotundifolia, Cyathula sp.* Near the stream-bed vlei grasses, *Setaria imberbis, Pennisetum unisetum, Cyperus spp.,* and many others occur. Reference will be made later to species which are more or less confined to the stream-banks (species of *Salix, Ficus,* etc.), but at this point emphasis must be laid on the fact that all the Thorn Veld species are found in such situations. The chief importance of the type lies in the fact that the species are close at hand, and can easily be distributed through the neighbouring grass-land. Careful attention has been paid to the means of distribution and to the requirements of each species. Only very few appear to be able to act as pioneers in the invasion. If we desire an expressive South African term, we may call them "Voortrekkers." When such pioneers have established themselves, they alter the conditions in the Grass Veld, and prepare the way for other species to follow them. The methods by which this is brought about forms the most interesting part of our investigation. In the Thorn Veld every stage of it can be seen clearly, but a similar succession of events can be seen in many other plant communities in South Africa.

THE INVASION OF GRASS-LAND BY TREES—PIONEER SPECIES.—The chief and only important pioneer species in the Bisley district is *Acacia arabica,* var. *kraussiana. Acacia horrida, Celastrus buxifolius, Vangueria infausta* and others also act as "voortrekkers," but at Bisley these species are of little importance, compared with *Acacia arabica.* It is obvious that as full a knowledge as possible of this chief pioneer, as regards its life-history, habits, and requirements, is desirable. It begins its growth as a straggling, thorny, irregularly-branched young tree. Gradually it assumes the umbrella form, and is usually more densely leafy than the majority of acacias. Its stipular thorns

are well developed, and whatever view be taken of the origin of thorns,* it cannot be doubted that its foliage is thereby protected against grazing animals. It fruits profusely, and the long indehiscent pods hang down below the branches well away from the thorns. The pods ripen irregularly, and some of the seeds may be ripe while the rest of the pod is green and succulent. Insects sometimes enter the pods and destroy the majority of the seeds, but such seeds as do ripen are very hard and resistant. It is the succulent pod itself, and not the seeds, that is the chief attraction for animals, and herbivorous mammals as well as birds may be the agencies for distribution, though in the case of the former probably only very few of the seeds remain undigested.† Goats are particularly fond of the pods, and fatten quickly when fed on them. The passage of the seeds through the animal's body assists in germination, helping to soften the very hard seed-coat. Otherwise seeds of acacias, it is found,

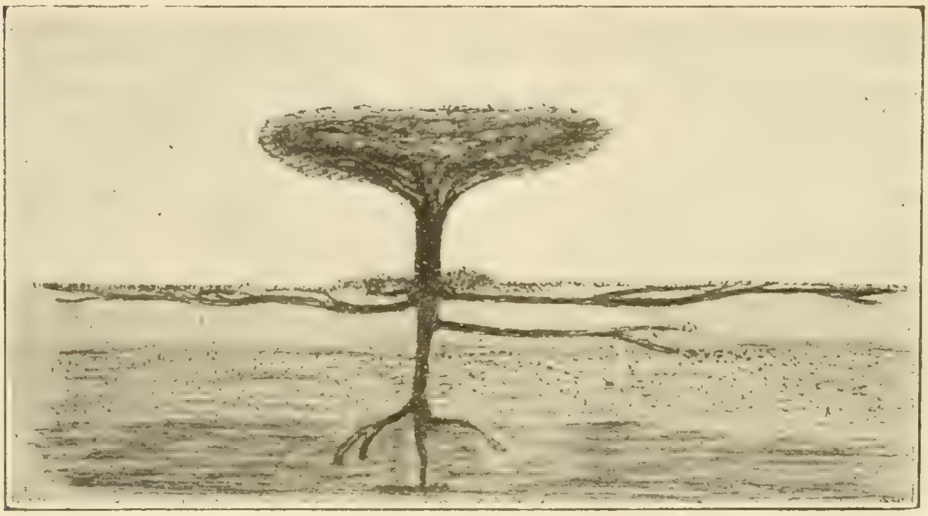


Fig. 1.—Diagram illustrating root system of *Acacia arabica* var. *kraussiana*.

do not germinate readily unless they have been first immersed in boiling water to soften the seed-coat. The seedlings appear usually singly through the grass, and not in clumps, but taking into consideration the fact that few of the seeds ripen and many are attacked by insects, while others may lie ungerminated, it is not difficult to understand why only single seedlings appear. For the first year or two the seedlings suffer from grass-fires, though it is surprising how much they will stand. A young

*See Bews, J. W., "The Growth Forms of Natal Plants," *Trans. Roy. Soc., S.A.* (1916.)

† Since the above was written this point has been further investigated. Mr. T. R. Sim kindly collected a large quantity of the ripe pods and forwarded them to Mr. Pole Evans, who arranged with Sir Arnold Theiler for feeding tests to be carried out in the Department of Veterinary Research. Numerous samples of seeds were returned to us which had passed through the bodies of herbivores uninjured. My colleague, Dr. Denison, has made a preliminary chemical analysis of the empty dry pods. They are very rich in carbohydrate (probably sugars).

plant may be scorched right to the top, yet new growth soon appears, and a year later it is little the worse. The root-system may be seen exposed where new dongas form, close to thorn-trees. (See Plate 6 *b*.) The main tap-root is vigorous in its growth, and descends as deeply as the soil permits, and often reaches a depth of many feet. It makes its way even through the shale as far as possible. The thorn-tree is thus rendered independent of atmospheric precipitation during the long dry season. In addition, however, to the main tap-root, there are usually a number of large side-roots, which spread out horizontally for great distances near the surface of the soil. These utilize such water as does not penetrate to any depth. The general appearance of the root system is illustrated in Fig. 1. The most important thing with regard to a pioneer species such as *Acacia arabica* is that it must be able to establish itself with no further shade or protection from the beginning than what is afforded by the surrounding grasses. Pioneer species can never at any stage of their life-history be ombrophilous, or at any rate, they are always less so than the species that follow

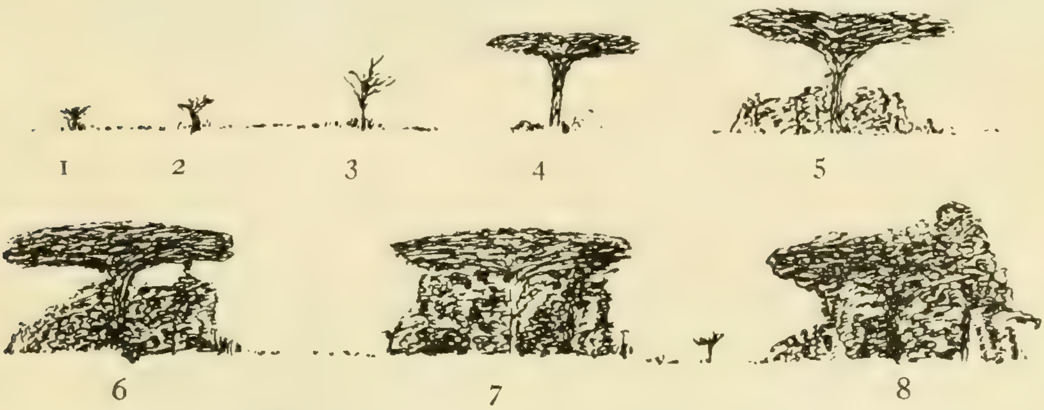


Fig. 2.—Diagrammatic representation of different stages in the Thorn Veld succession.

them. The critical period for the pioneer must be the earliest stage of the seedling, before its root has penetrated down to the deeper subterranean sources of water. Probably the laterally extended branch-roots which are near the surface help it to tide over this period by utilizing surface water. It must also be able to resist grass-fires

For the first six years the tree is straggling in growth and has little effect on the grass around it; but as soon as it begins to assume the umbrella form it throws enough shade to change the nature of the undergrowth. (Fig. 2, Stage 4.) At first the grasses grow taller, being to a certain extent etiolated. The soil becomes moister and earthworms more active. Their castings undoubtedly play an important part in changing the soil conditions and preparing a suitable seed-bed. Very often the white ant (termite) commences operations, if indeed it was not present before the seedling thorn tree, for, as will be pointed out later, seeds of all the species are apt to be dis-

tributed and to germinate on or around white-ants' nests. The excavations of termites have also an important effect on the soil. The nests are frequently afterwards deserted and occasionally the burrowings of the aard-vark or ant-bear. (*Orcyteropus afer*) leads to considerable disturbance of the soil, and provides further shade and shelter for young seedlings. As well as the white ants, true ants are frequently present in great numbers, and their effect on the soil in many places is most important of all. An early stage, at the time when the overhanging acacia is from 6 to 10 years old, is shown by the presence of such plants as the following: The grasses *Andropogon pertusus*, *Sporobolus indicus*, *Aristida angustata*; *Lantana salvifolia*, *Lippia asperifolia*, *Teucrium capense*, *Acalypha sp.*, *Lepidium sp.*, *Ocimum sp.*, *Leucas martinicensis*, *Vernonia sp.*, together with any of the other associated plants of the veld, but other invaders from the stream-bank and ravine flora soon make their appearance.

SPECIES WHICH FOLLOW THE PIONEERS (FIG. 2, STAGES 5-8).

Of the species which follow the pioneers (subsequent species) at Bisley, the earliest arrivals are jasmines (*Jasminum multipartitum* and *J. gerrardi?*). Their small fleshy drupes are readily eaten by birds. With them we get *Randia rudis*, which has a small black berry. This species, according to Sim, in some parts of the Fish River scrub forms a large part of the Bush vegetation. Another early arrival is *Ehretia hottentotica*, its fruit is an orange-red drupe, which is eaten by the natives. *Hippobromus alata*, with a black, pulpy fruit, is common at an early stage; it spreads by root-suckers, and young plants of it appear all round the parent tree. *Euclea undulata* (the guarri), a species which is dominant over wide stretches of the Little Karroo, sometimes appears under the thorn-trees among the first, but another species of Euclea (*E. lanceolata*) is more frequent. The Eucleas have berries, known as "guarri besjes," which are eaten by the natives. The wild grapes, especially *Vitis cirrhosa* and *V. cuneifolia*, are usually early arrivals. The large tuberous swellings on their roots are characteristic. Species of *Solanum* are also frequent. *Celastrus buxifolius*, as mentioned above, is sometimes itself a pioneer species; at other times it takes its place among the species which establish themselves in the shade of the thorn-trees. It has a capsule with two or three arillate seeds. *Zizyphus mucronata*, the "wait-a-bit" thorn, which has numerous fleshy, dark-red, globose fruits, is another widespread species of the Thorn Veld. It is often among the first invaders, but to establish itself it requires fairly deep soil or open rocky situations. The cabbage tree, *Cussonia spicata*, the fleshy fruits of which are eaten by birds, and the seeds of which do not seem to germinate readily unless they have been eaten, is another characteristic Thorn Veld species. Species of *Rhus* are very numerous. They have one-seeded

(*a*) Base of Colonization in a Ravine.

(*b*) Invasion of the grass veld by Thorn Trees.

(a) Subsequent species growing up underneath the Pioneer Acacia.

(b) Further stage in succession. The Pioneer Acacia being killed by subsequent species.

drupes. *Azima tetracantha*, a somewhat rarer species, was noticed once or twice: it has a globose berry.

The fruits of all those earlier invaders have been noted because it is significant that they are all of the fleshy type which are eaten by animals, and especially by birds. These are the agents of distribution, and wind-distribution seems to play a very unimportant part in the establishing of the Thorn Veld as a vegetation type. The lower branches of the thorn-tree, bare of spines and shaded by the spreading overhead canopy, are the favourite resting-places for birds. They feed in the stream-bank bush, and such species of that bush as have fruits that are eaten are naturally the first to be distributed through the Thorn Veld. Afterwards other species arrive, the majority of them also distributed by birds and other animals, though some of them are not: *Dalbergia obovata* (woody liane), *Calpurnia sp.*, *Chilianthus arboreus*, *Vangueria infausta*, *Sclerocarya caffra*, *Harpephyllum caffrum* (Kafir plum), *Combretum kraussii*, *Pavetta lanceolata*, *P. sp.*, *Xanthoxylon capense*, *Gymnosporia*, (*Celastrus*) *sp.*, *Elæodendron æthiopicum*, *Grewia caffra*, *Royena pallens*, *R. spp.*, *Plumbago capensis* (liane), *Brachylæna discolor*.

The young plants of the various species named grow up through the herbaceous and shrubby species which form the preliminary stage, and soon a tangled growth results (see plate 8). The soil is loosened, and a certain amount of humus even collects; other herbaceous species appear, such as *Sanseviera thyrsiflora*, *Kalanchoe rotundifolia*, *Barleria obtusa*, *Asparagus spp.*, *Scilla sp.*, and a parasitic species of *Melasma*.

Further Stages in the Succession

Very soon the species which began under the thorn-tree grow up through it. At a fairly early stage it is common to find *Celastrus* or *Ehretia* towering above it (Fig 2, Stage 8). The lianes, such as *Vitis cuneifolia*, *V. cirrhosa*, *Asparagus spp.*, sometimes spread all over the top of it, and the thorn-tree may ultimately be killed. On the other hand, where herbivorous animals are abundant, unprotected species are kept down as a result of grazing, and even old thorn-trees have no undergrowth whatever. In this case the succession is limited, and the Thorn Veld remains as pure acacia veld. The thorn-trees themselves, however, grow closer and closer together, especially if the grazing prevents grass-fires, and ultimately we get pure thorn-thickets. The more natural succession is seen where grazing animals are not abundant or are excluded by areas being fenced in. The clumps which grow round pioneer thorn-trees at first are scattered, as the pioneers themselves were, but the intervening areas are colonized by more thorn-trees, which, in turn, produce clumps, and soon a stage is reached where the branches of separate thorn-trees touch. By this time many other species of trees have arrived, and they are not all distributed by animals. A new struggle commences, and the climax type is the succulent

or thorny scrub, which is so characteristic of many river valleys in Natal. There are present very much dwarfed forest species, such as *Ptæroxylon utile, Elæodendron croceum, Scolopia zeyheri, Schotia latifolia, Toddalia lanceolata, Clausena inæqualis, Xanthoxylon capense,* and woody lianes (*Dalbergia obovata*), as well as a number of succulent or semi-succulent lianes, such as *Sarcostemma viminalis, Dregia floribunda, Riocreuxia sp., Capparis spp., Secamone sp., Ceropegia sp., Cissampelos sp., Senecio sp.* It should be noted that over most of the Thorn Veld the pioneer acacias remain the dominant species in the climax stage. Reference to the list which follows, however, will show that other species are locally dominant, and, as mentioned above, in many cases the pioneer thorn-tree is killed by the species which follow it. Within the Thorn Veld, therefore, the succession tends to be towards the mesophytic. But whether the thorn scrub should be considered a more mesophytic type than the grass-land which it replaces is, of course, another matter. Grassland, however xerophytic it be, is not the climatic type suited to the valleys, which are very hot, and have a long, dry period in winter, but where there is a sufficient supply of water at a certain depth—too deep for grass roots to reach it. Schimper's basic distinction between grass-land and wood-land climates here appears to be a very sound one. As we pass from the higher veld of the hills and upper plateaus to the Low Veld of the valleys, we pass from a grass-land climate, which is locally (on the south-eastern slopes) a mesophytic forest climate, first of all, to a climatic area which produces a Low Veld type of grass-land with the tufted, low-growing variety of anthistiria dominant, and finally to Thorn Veld and thorny scrub, a xerophytic type adapted to withstanding long periods of drought and intense heat.

List of Thorn Veld Species.

The following list includes the more important and characteristic species of trees, shrubs, and lianes found in the Thorn Veld and thorny scrub. The symbols denoting frequency of species are those in general use:—

d. = dominant, l.d. = locally dominant, l.s.d. = locally subdominant, a = abundant, l.a. = locally abundant, f = frequent, l = local, o = occasional, r = rare, v.r. = very rare.

Ranunculaceæ—

Clematis brachiata l.a.

Menispermaceæ—

Cissampelos burchelliana f.

Cappărideæ—

Cadaba natalensis	o.	Capparis albitrunca	l.a.
,, juncea	o.	,, zeyheri	l.a.
Niebuhria triphylla	o.	,, gueinzii	l.a.
Boscia caffra	o.	,, citrifolia	l.a.
		,, corymbifera	l.f.

Bixineæ—

Scolopia zeyheri	f.	Trimeria alnifolia	l.f.
Dovyalis caffra	o.	„ trinervis	l.f.
Aberia tristis	f.	Kiggelaria africana	o.

Pittosporeæ—

Pittosporum viridiflorum	l.f.

Portulacaceæ—

Portulacaria afra.	l.s.d.

Sterculiaceæ—

Dombeya rotundifolia	o.	Dombeya natalensis	o

Tiliaceæ—

Grewia caffra	a.	Grewia flava	l.a.
„ lasiocarpa	l.f.	„ occidentalis	f.

Lineæ—

Erythroxylon monogynum	l.f.

Rutaceæ—

Toddalia lanceolata	l.f.	Xanthoxylon capense	l.f
Clausena inæqualis	f.		

Ochnaceæ—

Ochna arborea	l.f.	Ochna atropurpurea	l.f.

Burseraceæ—

Commiphora harveyi.	o.	Commiphora caryæfolia	o.

Meliaceæ—

Ekebergia capensis	l.f.

Olacineæ—

Cassinopsis tinifolia	v.r.

Celastrineæ—

Cassine capensis	f.	Celastrus undata	f.
Elæodendron croceum	f.	„ capitata	o.
„ kraussianum	f.	„ albata	l.f.
„ sphærophyllum	f.	„ angularis	l.f.
Putterlickia verrucosa	f.	„ acuminata	r.
„ pyracantha	f.	„ buxifolius	a.

Rhamneæ—

Zizyphus mucronata	l.a.	Scutia commersoni	l.d.
Rhamnus prinoides	o.	Helinus ovata	f.

Ampelideæ—

Vitis cirrhosa	l.a.	Vitis, many other species	f.
,, cuneifolia	l.a.		

Sapindaceæ—

Ptæroxylon utile	o.	Hippobromus alata	a.
Schmidelia erosa	l.f.	Dodonæa thunbergiana	l.a.
,, monophylla	o.	Melianthus spp.,	l.a.
Pappea capensis	o.	Bersama lucens	o.

Anacardiaceæ—

Rhus discolor	l.f	Rhus, other species	f.
,, glaucescens	f.	Smodingium argutum	l.a.
,, tomentosa	a.	Odina caffra	l.f.
,, obovata	a.	Sclerocarya caffra	l.a.
,, villosa	a.		

Leguminoseæ—

Indigofera spp.,	l.f.	Crotalaria spp.,	l.f.
Psoralea pinnata	l.f.	Albizzia fastigiata	l.a.
Milletia caffra	l.a.	Dichrostachys nutans	l.a.
Dalbergia obovata	l.a.	Cassia obovata	l.f.
Erythrina tomentosa	l.f.	,, occidentalis	l.f.
,, humiana	o.	,, tomentosa	l.f.
,, acanthocarpa	v.r	Acacia arabica var. Kraussiana	d.
,, caffra	l.a	,, caffra	l.d.
Calpurnia spp.,	l.f	,, gerrardi	l.
Elephantorrhiza burchellii	l.	,, horrida	d.
Schotia brachypetala	f.	,, hirtella	f.
,, latifolia	f.	,, pennata	l.f.
,, speciosa	l.f.	,, other species	f.

Rosaceæ—

Rubus rigidus	f.	Cliffortia strobilifera	l.

Hamamelideæ—

Myrothamnus flabellifolius	l.d.		

Rhizophoreæ—

Cassipourea verticillata	l.		

Combretaceæ—

Combretum apiculatum	o.	Combretum gueinzii	o.
,, erythrophyllum	o.	,, kraussii	f.
,, glutinosum	o.	,, salicifolium	l.f.
		,, riparium	o.

Lythrariæ—

Heteropyxis natalensis	v.r.		

Samydaceæ —

Homalium rufescens	l.		

Umbelliferex—

Heteromorpha arborescens	l.		

Araliaceæ—

Cussonia spicata	a.	Cussonia umbellifera	l.a.
„ paniculata	o.		

Rubiaceæ—

Randia rudis	a.	Plectronia spinosa	l.f.
Kraussia lanceolata	l.	„ ventosa	l.f.
Gardenia globosa	o.	„ ciliata	l.a.
Alberta magna	r.	„ gueinzii	l.f.
Vangueria infausta	o.	„ pauciflora	l.a.
„ lasiantha	o.	„ mundtii	l.f.
„ venosa	o.	Pavetta caffra	f.
„ caffra	o.	„ lanceolata	f.

Compositæ—

Vernonia corymbosa	l.f.	Brachylæna discolor	f.
Tarchonanthus camphoratus	o.	„ elliptica	o.
Senecio spp.,	l.f.	Osteospermum moniliferum	o.

Plumbagineæ—

Plumbago capensis	l.a.		

Myrsineæ—

Mæsa rufescens	l.	Myrsine melanophleus	f.

Sapotaceæ—

Sideroxylon inerme	l.a.	Mimusops obovata	o.

Ebenaceæ—

Royena cordata	o.	Royena lycioides	l.a.
„ hirsuta	o.	Euclea daphnoides	f.
„ villosa	o.	„ lanceolata	f.
„ pallens	f.	„ undulata	l.a.
„ pubescens	o.		

Oleaceæ—

Jasminum multipartitum	a.	Jasminum streptopus	f.
„ glaucum	f.	Olea verrucosa	l.a.
„ gerrardi	f.	Schrebera alata	r.

Apocynaceæ—

Carissa arduina	f.	Acokanthera venenata	l.a.
Rauwolfia natalensis	l.a.	Voacanga dregei	l.a.

Asclepiadaceæ—

Sarcostemma aphyllum	f.	Ceropegia spp.,	f.
Saracostemma viminale	f.	Riocreuxia sp.,	f.
Dregea floribunda	a.	Secamone sp.,	f.

Loganiaceæ—

Nuxia congesta	l.f.	Chilianthus oleaceus	l.a.
Buddleia salviaefolia	f.	„ lobulatus	l.f.
Strychnos spinosa	l.f.	„ dyssophyllus	l.f.

Boragineæ—

Ehretia hottentotica	a.	Cordia caffra	a.

Solanaceæ—

Solanum spp.,	a	Lycium hirsutum	l.a.

Scrophulariaceæ—

Bowkeria spp.,	o

Bignoniaceæ—

Rhigozum trichotomum	l.a.

Verbenaceæ—

Vitex mooiensis	o.	Vitex obovata	o.

Labiatæ—

Leonotis leonurus	f.

Phytolaccaceæ—

Phytolacca octandra	f.	Phytolacca stri ta	f.

Proteaceæ—

Faurea saligna	l.d.

Thymelaceæ—

Dais cotinifolia	o.	Lasiosiphon linifolius	f.
Peddiea africana	f.	Lasiosiphon kraussii	f.
Lasiosiphon meisnerianus	o.		

Loranthaceæ—

Loranthus spp.,	f.	Viscum spp.,	f.

Santalaceæ—

Osyridocarpus natalensis	o.	Colpoon compressum	o.

Euphorbiaceæ—

Euphorbia tirucalli	l.d.	Securinega verrucosa	l.a.
„ grandidens	l.d.	Cluytia pulchella	l.a.
„ tetragona	l.d.	Bridelia micrantha	l.
Cyclostemon argutus	o.	Ricinus communis	f.
Dalechampia capensis	f.	Excoecaria caffra	l.a.
		Excoecaria africana	l.a.

Urticaceæ—

Ficus capensis	l.f.	Celtis kraussiana	o.
Ficus natalensis	l.f.	Trema bracteolata	o.

Salicineæ—

Salix capensis	l.d.	Salix woodii	o.

Palmæ—

Phœnix reclinata	l.f.

Liliaceæ—

Asparagus spp.,	f.	Behnia reticulata	o.
Aloe spp.,	f. to d.		

Cycadaceæ—

Encephalartos altensteinii	l.f.

VARIATIONS IN THE THORN VELD—SUB-FORMATIONS.

As is to be expected, the very great area occupied by Thorn Veld or Thorn Scrub at its climax stage is not a uniform habitat. There are many local variations throughout it, and the following separate types should be recognised.

(1) *Thorn Veld towards the Coast.*—The Thorn area at lower altitudes towards the coast is free from frost in winter, and several of the species included in the above list only occur in such frost-free localities. This sub-type, therefore, is determined by a climatic variation. The following are the species referred to:—

Erythroxylon monogynum, Dodonaea thunbergiana, Bersama lucens, Sclerocarya caffra, Milletia caffra, Albizzia fastigiata, Dichrostachys nutans, Cassipourea verticillata, Heteropyxis natalensis, Homalium rufescens, Cussonia umbellifera, Kraussia lanceolata, Strychnos spinosa, Cordia caffra, Cyclostemon argutus, Bridelia micrantha, Excœcaria caffra, E. africana, Phœnix reclinata. The plant succession on the coast also differs in detail, though it is essentially similar to that described above. Many variations in the succession, of course, can be seen in almost every different locality. It depends upon what species are abundant in the neighbourhood (in the areas which serve as bases for colonization).

(2) *Rocky Places.*—Here the soil conditions are much more irregular than over the rest of the Thorn Veld. The rocks and stones conserve moisture, and shelter is provided for seedlings. Such places are also more frequented by birds and other animals, and consequently seeds are more likely to be brought there. Almost any of the Thorn Veld species may be found in such situations, but some are particularly characteristic of them, and are rarely found elsewhere. The aloes are often pioneers, and may remain dominant. The speckboom (*Portulacaria afra*)

is another characteristic species, often dominant or sub-dominant. *Myrothamnus flabellifolius* is dominant in certain localities. Over steep, rocky slopes the euphorbias are dominant in many of the main river-valleys. Other typical rocky species are: *Acacia caffra*, var. *rupestris, Encephalartos altensteinii, Olea verrucosa, Celastrus albatus, Maesa rufescens, Plectronia ciliata, Carissa arduina.* Not only are the other Thorn Veld species present as well as those species named, but there is also much greater variation in the succession in rocky places. This may be explained by the fact that in the open veld the number of pioneers is restricted, because there is no shade or shelter for the seedlings, and only a few are able to establish themselves under such conditions. In rocky places, however, there is a certain amount of shelter provided until the young plants have reached a more or less permanent water supply, and they are also protected from grass fires. More mesophytic species, therefore, in this case are able to act as pioneers.

(3) *Moist Spots and Stream-banks.*—As mentioned above, the ravines and stream-banks are areas where the Thorn Veld species are first distributed and enabled to establish themselves, and such areas serve as bases for the colonization of the rest of the veld. Once more, any of the Thornveld species may be found in such situations, but there are a number of species which do not leave it or do not occur, except rarely, elsewhere. These, named roughly in the order of their importance, are: *Salix capensis, S. woodii, Ficus capensis, F. natalensis, Eugenia cordata, Acacia caffra, Rauwolfia natalensis, Combretum salicifolium, Trema bracteolata, Pittosporum viridiflorum, Rhus viminalis, Royena pallens, Macaranga capensis, Grewia lasiocarpa, Melianthus spp., Cliffortia strobilifera, Trimeria alnifolia, T. trinervis, Burchellia capensis, Voacanga dregei, Psoralea pinnata, Bowkeria triphylla, Gnidia ovalifolia, Ochna atropurpurea, Excoecaria africana, Myrica æthiopica, Hypericum lanceolatum, Dissotis eximia.* In many places, however, the stream-banks are free from bush, and are fringed by various grasses, reeds and sedges, *Phragmites, Setaria, Erianthus, Typha, Cyperus,* etc.

The above types are all so distinct that they might very well be considered separate formations. Further research will doubtless bring to light other distinct types depending on local variations in climate or in soil conditions. It was noted above that other species besides *Acacia arabica* often acted as pioneers. Taking the Thorn Veld as a whole, the essentially similar *Acacia horrida* is more frequently the chief pioneer and the dominant species. It is not so easy to explain the differences between types dominated by such closely allied species. They do not seem to be determined by any clearly marked variations in the habitat, though further research may demonstrate this to be the case. It is probable that the factors controlling seed-dispersal are of considerable importance in this connection.

Undergrowth in the Thorn Veld.

The herbaceous undergrowth in Thorn Veld and Thorn Scrub is not luxuriant, but it includes a large number of species which occur more or less sporadically. Some of the more characteristic ones have already been mentioned. The species vary considerably in different parts of the country. There are a number of ferns—*e.g.*, *Cheilanthes hirta*, *Doryopteris concolor*, *Pellæa viridis* with var. *glauca*, *Asplenium cuneatum*, *A. furcatum*, *Dryopteris bergiana*, *Ceterach cordatum*, *Mohria caffrorum*, *Ophioglossum vulgatum* (occasional), with *Adiantum capillis-veneris* and *Dryopteris thelypteris* in wet places, *Pellæa hastata* on stones, and *Dryopteris athamantica* in ant-bear holes. The numerous bulbous plants are more characteristic of the open veld, but many of the veld species occasionally occur under the thorn-trees—*e.g.*, species of *Scilla*, *Ornithogalum*, *Drimia*, *Albuca*, *Urginea*, *Tritonia*, etc. Species of *Asparagus* are also characteristic of open veld as well as under thorn-trees, but they, on the whole, prefer the latter situation. *Sanseviera thyrsiflora* (Hæmodoraceæ) is a very characteristic species among the undergrowth. Among the Dicotyledons various Labiatæ—*e.g.*, *Ocimum spp.*, *Orthosiphon spp.*, *Leucas spp.*—are common. There are several Acanthaceæ which are frequent, *Barleria obtusa*, species of *Peristrophe*, *Hypœstes*, *Justicia*, *Isoglossa*, etc. Verbenaceæ are represented by *Lantana salvifolia*, *Lippia asperifolia*, and others. Some of the parasitic Scrophulariaceæ, such as *Melasma*, *Harveya*, are occasionally found. The various climbing Asclepiads already referred to are quite a feature in places. *Dregea floribunda*, *Sarcostemma viminalis*, *Ceropegia spp.*, and *Riocreuxia torulosa* are among the commonest. The stem succulent, *Huernia hystrix*, also occurs, though it is more characteristic of open veld, sometimes covering the nests of *Termes latericius*. Species of *Crassula* are common in rocky places. *Polygala spp.* are occasional. The very large number of species belonging to the Orders Leguminoseæ and Compositæ so abundant in the open veld are not common under the thorn trees. They prefer full sunlight.

Seed Dispersal in the Thorn Veld.

As already pointed out, wind plays a very unimportant part in the dispersal of the Thorn Veld species. This, indeed, applies generally to all forest species in South Africa. There are not very many Compositæ in the Thorn Veld, and even among them some— *e.g.*, *Osteospermum*—are not distributed by wind. The species of *Combretum* have winged fruits, but they are not carried very far from the parent tree. In the few cases where the seeds or fruits are carried by the wind it is possible that the very numerous large spiders' webs (*Argiope sp.*) which are such a common feature of the Thorn Veld, stretching between the branches of the thorn-trees or between separate trees, may play an important part in catching such seeds. They would

thus be deposited ultimately below the thorn trees like the seeds which are carried by birds.

Of the species included in the list given above, about 60 per cent. have fruits which are fleshy, and are obviously distributed by birds and other animals. The remainder have dry fruits, but the seeds of many are eaten, and presumably some are not digested. Others (*e.g.*, *Plumbago capensis*) are carried on the coats of animals. Various water birds, such as the ducks, teals, herons, storks, cranes, bitterns, as well as snipe, plover, etc., feed in the colonization areas where the seeds of the various species have fallen on to the mud by the side of the water. These birds fly from one area to another, and carry seeds or fruits adhering to their feet or bills. As to the feeding habits of the birds and other animals of South Africa, while various general observations have been made, little in the way of detail is known. This is unfortunate, because there are many points in which the ecology of animals and plants should be connected, and the complete story of the succession in none of our plant communities will be thoroughly understood until this connection is demonstrated. Among the birds of South Africa, the *Columbæ* (pigeons), of which there are about a dozen species, feed mostly on the fruits of trees, and are of prime importance in connection with the dispersal of seeds. Some of them are very fond of acacia pods. There are also about a dozen different kinds of starling, which eat fruits and seeds as well as grubs, beetles, termites, etc. Other birds which are important as distributing agents are the orioles, the thick-billed weaver bird (*Amblyospiza albifrons*), bulbuls (three or four kinds), one or two of the thrushes, the bush black cap (*Lioptilus nigricapillus*), the mouse birds, the trumpeter hornbill (*Bycanistes bucinator*) and other hornbills, the barbets and tinker birds, the Knysna plantain-eater or lourie (*Turacus corythaix*), and two other louries and the parrots. These are all fruit-eaters. The great host of weaver birds, waxbills, finches, widow birds, buntings, seed-eaters, canaries, larks, etc., eat small fruits and seeds as well as insects, but they are not of so much importance.

Among the mammals, the fruit bats, which are common, are, as the name implies, fruit-eaters, and it is important to note that they often carry the fruit away with them to feed on it at their leisure. The squirrels are also very important; not only do they eat berries and fruits, but they collect and bury stores of nuts, some of which remain and germinate. Sclater* states that the chief food of the vervet (*Cercopithecus lalandii*) is the gum and fruits of acacias. The baboon (*Papio porcarius*) is omnivorous, and eats fruits amongst other things. The lemur or bush baby (*Galago moholi*) lives on pulpy fruits and insects. The bush pig (*Potamochœrus chœropotamus*) eats roots and fruits. The duiker, springbok, kudu, eland, inyala, bushbok and other antelopes eat fruits as well as grass and

*Sclater, W. L., "The Fauna of South Africa—Mammals" (1901).

shoots, and doubtless sometimes are agents in distribution. Sclater (*loc. cit.*) describes 36 species of South African antelope, but many of them, though formerly abundant, are now rare or almost extinct. The African elephant, now in South Africa confined to the Addo scrub, must formerly have been an important agent. Its food consists of leaves and twigs, wild fruits and roots, seldom grass. The Cape gerbille (*Gerbillus afer*) is very common, and portions of the veld may be riddled with its burrows. Its food consists of bulbs and seeds. The rats, of which the commonest is apparently a brown variety of the black rat (*Mus rattus*) are omnivorous, and may be of importance. Ants (true ants, not termites) are very abundant in the Thorn Veld, and apart from their effect on the soil, some of them store seeds which they may bring from a considerable distance. Plants, the seeds of which have special adaptations for dispersal by ants, such as a brightly-coloured caruncle containing oily food-material (elaiosome), are known as myrmecochorous plants. Sernander * has written a monograph of European myrmecochorous plants, reviewed by Weiss in the *New Phytologist*, 1908. Weiss† has also described the dispersal of the seeds of the gorse and the broom by ants. I have made a number of preliminary experiments by placing seeds of various plants near a nest of the ant *Tetramorium squamiferum*. In the nests of this ant collections of seeds are found stored in special chambers. Grass seeds predominate. When ten seeds of the grass *Paspalum scrobiculatum* were placed near a nest, they were all removed in about nine minutes. Other grass seeds were also readily carried away. The order of preference was then determined by placing eight different kinds of seeds (six of each), and observing how many were left at intervals of 15 minutes. The experiment was repeated several times and at different nests. Other experiments with different sets of seeds were also carried out. The following seeds were observed to be carried away readily: *Paspalum scrobiculatum*, *Phalaris arundinacea*, *Hibiscus trionum*, *Teucrium riparium*, *Abutilon sonneritianum*, *Argemone mexicana*, *Sida rhombifolia*, *Nicandra physaloides*, *Indigofera sp.*, *Datura stramonium*, *Sonchus sp.* Even fairly large seeds like *Cassia occidentalis* were taken, sometimes two ants co-operating to remove one seed. Small seeds, on the other hand—*e.g.*, *Amarantus retroflexus*, *Chenopodium botrys*, *Plantago major*, *Rumex obtusifolius*—were not touched. On examining those various seeds under the microscope, in the majority no special elaiosomes or other adaptation could be distinguished. However, in *Hibiscus trionum* there are little tufts of hairs, some of them glandular, dotted over the surface of the seed. In *Teucrium*, the whole surface of the seed is covered with glandular hairs, which microchemical tests

* Sernander, R., "Entwurf einer monographie der Europäische myrmecochoren." *Kungl. Svenska Vetenskapsakademiens Handlingar* (1906).

† Weiss, F. E., *New Phytologist*, **8**, [3], (1909).

showed to be rich in proteids and oils. These seeds, therefore may possibly be considered as myrmecochorous like those described by Sernander, but, if so, the ants did not seem to show any very marked preference for them. Other seeds were carried away as readily.

Experiments were also carried out with another smaller species of *Tetramorium*. This species removes the husks from the grass seeds and throws the former outside its nest in little heaps. These preliminary investigations are sufficient to show that ants are important agents for seed dispersal in the veld of South Africa. Further experiments on the subject are in progress.

The Importance of Termites.

According to Fuller, "in Natal and the Transvaal it is no exaggeration to say that the soil is riddled from end to end of the country with termite tunnellings through which an inconceivable host of insects constantly passes to and fro."* In two small areas of Pietermaritzburg (784 sq. yards each) he reported finding 14 and 16 nests respectively, the homes of six different species, an observation based solely upon surface indications; while at Pretoria, while excavations for the foundations of Government buildings were being made, it was found that the soil was inhabited by eight species. "To a depth of four to five feet it was riddled with their galleries, and not a cubic yard existed which did not contain one or more cavities belonging to one species or another." The white ants form nests varying in form and position according to the species. They are not all mound-builders, and the juvenile nests even of the species that are, are often moundless. Apart from the extremely important effects on the soil conditions, which doubtless has a good deal to do with preparing the way for tree growth, and the effect also on the vegetation itself (both grasses and trees) there are various biological agencies other than the white ants themselves which are brought into operation. The mounds of *Termes natalensis, T. latericius, T. vulgaris,* and especially *Eutermes trinervius*, are conspicuous features of the landscape. The outer parts of the mounds are carefully closed by cemented pellicles to exclude enemies. As long as the nest is inhabited these mounds are increased in size and repaired against the effect of denudation. Birds flying over the veld naturally alight on such mounds. They scatter seeds which roll down or are washed down over the outside of the mound and find a suitable germinating ground among the fringe of grasses which surround the mound, or they may germinate on the mound itself. This doubtless explains why a primary clump of Thorn Veld species is so often established on the site of an old termites' nest. The succession here differs, therefore, somewhat from that outlined in the first part of this paper, but it

*Fuller, Claude, "Observations on Some South African Termites," *Ann. Nat. Mus.*, 3 [2], (1915).

Grassveld with nests of *Termes trinervius.*

The establishment of Thorn Thickets.

will be seen that it is essentially similar. The pioneer species are the same as those represented in the early stages, as described above, their fruits being such as are eaten by birds.

Summary and Conclusions.

Since Tree Veld is such an extensive and important type in South Africa, as well as in the continent as a whole, the detailed investigation of the plant succession in such a type is of the greatest importance. The species of trees, shrubs and lianes composing the Thorn Veld first establish themselves in the ravines and near the stream-banks, where the birds and other animals which serve chiefly as distributing agents first bring the seeds. Such areas serve as bases of colonization for the intervening areas.

The acacias, especially *Acacia horrida* and *A. arabica*, var. *kraussiana*, are the chief pioneer species. They are shown to be well adapted to establishing themselves with no shade, shelter or protection against grass fires.

After they have prepared the way, a great many other species follow them, and after germinating in the seed-bed prepared for them by the activity of earthworms, termites and ants underneath the thorn-tree, they grow up in the shade.

Various stages have been traced, and ultimately the subsequent species may kill the pioneer. As a rule, however, the thorn-trees remain dominant in what is, at present, over the largest areas, the final stage (Thorn Scrub).

A list of over 230 species of trees, shrubs, and lianes belonging to the Thorn Veld is given with symbols denoting frequency, and the undergrowth is also described.

Three important sub-formations are distinguished, viz., Thorn Veld towards the coast, the Thorn Veld of Rocky Places and the Stream-bank type in the Thorn Veld area, but it is pointed out that these might very well be considered as separate formations.

The question of seed-dispersal is discussed at length. Wind distribution plays a relatively unimportant part. The chief agents of dispersal are birds, but for species with capsular fruits and small seeds, ants, which are very abundant in the Thorn Veld area, are also important in connection with dispersal. The influence of white ants (Termites) on the plant succession is also discussed.

In conclusion, I must express my thanks to Mr. T. R. Sim, who is always ready to put at my disposal his unrivalled knowledge of the distribution of species in South Africa, and also to Mr. J. S. Henkel for many helpful suggestions.

Explanation of Plates.

Plate 6, *a.*—*Acacia arabica* var. *kraussiana*, growing near a nest of *Termes trinervius*. Note the umbrella form. The undergrowth has here been kept down by goat grazing.

Plate 6, *b*.—Donga showing the root system of *Acacia arabica*, var. *kraussiana*. The main taproot descends to the deeper water supplies. Large lateral roots spread out along the surface.

Plate 7, *a*.—Base of colonization in a ravine. For full list of species occurring here, see p. 3.

Plate 7 *b*.—Invasion of the grass veld by thorn trees. Note the presence of termites' nests and young thorn trees in the foreground. The base of colonization extends across the middle background.

Plate 8, *a*.—Subsequent species growing up underneath the pioneer acacia. *Randia rudis*, *Ehretia hottentotica*, *Celastrus buxifolius*, *Hippobromus alata*, *Euclea lanceolata*, *Jasminum multipartitum*, *J. gerrardi* and a climbing asparagus over the top.

Plate 8, *b*.—Further stage in succession. The pioneer acacia being killed by the subsequent species. *Elæodendron æthiopicum*, *Hippobromus alata*, *Celastrus buxifolius*, *Asparagus* sp., *Rhus* sp., *Azima tetracantha*, *Randia rudis*, *Euclea lanceolata*, *Jasminum gerrardi*, with *Sanseviera thyrsiflora* and *Huernia hystrix* abundant as undergrowth.

Plate 9, *a*.—Thorn thicket. *Acacia arabica*, var. *kraussiana*, dominant. *Acacia horrida* also present. The foreground shows the succession from grass veld.

Plate 9, *b*.—Grass veld with nests of *Termes trinervius*. Early spring condition. This was formerly Thorn Veld, but the trees have been cut down for firewood.

(*Read*, *July* 4, 1917.)

Einstein's Theory of Gravitation.—Sir F. W. Dyson* observes that, according to Einstein's theory, a ray of light grazing the sun's limb should be deflected. Photographs taken by Davidson with the astrographic equatorial, on the occasion of the solar eclipse of 1905, have been examined, but the results were not sufficiently accordant, and it is suggested that special arrangements should be made to obtain photographs during the eclipse of May 29th, 1919, for the critical analysis of the effect. A list of stars available for instruments of the astrographic type has been prepared, together with the computed displacement that should be shown if the theory be correct.

* *Roy. Astron. Soc., M.N.* 77, 445-447, March, 1917.

MARKETS.

By Pieter Johannes Du Toit.

The term "market" is usually regarded in a vague general way, leading one to conclude that markets are selling places which can absorb without limit any products which might be raised. That would be the case if one of the two parties who make a market possible, the seller, were content to let the buyer have his produce at the buyer's own price. But since the seller desires to live, his requirements for continuing his existence obviously call for a return for his labour which, as far as he is able by his intelligence, physical exertion or other means to make it so, will at least suffice for that purpose. Markets are, therefore, selling places limited by the prices which the buyer is prepared or able to pay and which the seller at the same time is prepared or able to accept. The extent to which the buyer is likely to meet the seller determines the extent to which the seller will meet the buyer, that is, to which the seller will grow a product which the buyer requires. The farmer will produce according to the market he has. He will not and cannot reasonably be expected to produce more, because he cannot in justice to himself and his dependents produce at a loss, or even at a less profit than that which he may deem to be a fair return for his expenditure of labour, of money, of implements, of seed and so forth. Greater market must therefore precede increased production.

The farmer has to include in his expenditure the cost of obtaining his requirements for producing and the cost of placing on the market what he has produced. Length of railways and of roads, distance from a railway line, bad roads, absence of necessary bridges, mountainous country—all add to the cost of production; and since each producer has to compete with others in his own market, these disadvantages determine the extent to which he will produce a particular commodity and the nature of the commodities which he will grow. It may, for example, not pay him to grow more wheat than he requires for his own use: he may not be able to place a surplus above his requirements in successful competition with other growers of wheat. The same causes may operate in favour of his deciding on stock-raising in preference to agriculture. As these disabilities disappear or are lessened, he might find it more profitable to alter his farming practice by combining extensive agriculture with stock-raising, or even giving the former the chief place in his operations. In other words, the conditions under which he lives may, by being altered, such as by the building of railways, or by education, or by the discovery of minerals and the building up of an industrial centre near by, influence profoundly his farming practice. But the economic structure on which his operations are based must be changed before he can suffer a departure from those operations themselves. Let us take the cattle industry.

The construction of a railway line may for a considerable distance along that line become an active force in inducing the production of dairy products rather than of beef.

The farmer having decided what he will produce in his own interests and to his best advantage—and if his decision is not made with care and discretion he will go under—the extent to which he can sell at a price which he may deem remunerative determines, as already indicated, the extent to which he will produce. The wine industry in South Africa has been practically stationary for twenty-five years and more. It often suffers severe barometric changes of price in the same year. The wine farmer's market being limited, he produces what experience has taught him to be sufficient to maintain the selling price at an average level of £4 to £5 per leaguer. Climatic conditions may vary the quantity produced from a half to a full crop. If the yield is a full one, there is over-production, and the price for distilling wine drops to £3 and £3 10s. per leaguer. If the yield is a small one, the price soars to £6 or even to £8. An export trade to a large market would steady prices, allow of the producer investing with confidence because he could calculate his probable return per acre, and stimulate greater production. There is no clearer illustration than is to be found in the ostrich feather industry as to the effect of a market contracting. A sudden change of fashion abroad, followed by the European War, precipitated a catastrophe. The price fell from £2 17s. 9d. per pound at the end of 1913 to £1 16s. 6d. in 1914, 15s. 8d. in 1915, and £1 1s. 6d. in 1916. The number of ostriches was 746,657 in 1911, and 399,028 in 1916, and serious thought is being given to a proposal that exportation should be prohibited for a period or curtailed in order to create a scarcity in the American and European markets and force up prices. Another example—one fresh in the minds of South Africans. Owing to the greater demand created by the European War for meat, prices, already on the up-grade before the war, increased to an extent which made South Africa's entry into the European market a success far sooner than would otherwise have been the case. The greater demand for cattle naturally increased their price. Probable conditions after the war encourage the belief that the market will continue to be active. Attention is therefore immediately given to improving the beef breeds of cattle in this country, to feeding and to greater production.

Fruit and maize cultivation increased rapidly with the opening up of oversea markets.

The extent to which the farmer will produce being determined by market considerations, the most profitable market for him is the one which is reached most cheaply and in which demand exceeds or at least equals supply. As soon as supply exceeds demand in the local market, produce begins to be transferred to the next nearest market in which the opposite condition (demand exceeding supply) obtains. And for the same reason the best market may recede until it has to be found thousands of

miles away. The wheat growers of Malmesbury first supplied the village of Malmesbury, next Capetown and afterwards Kimberley, Bloemfontein, and Johannesburg. The maize grower of Ermelo first supplied the village of Ermelo, then Johannesburg, and latterly the United Kingdom and other European countries. It may be of greatest advantage to a country to market one product within its borders and another beyond them. Again, a more advantageous market might be found nearer than the present most profitable one. The United States of America exported meat to the United Kingdom until its own demand absorbed the whole of its supply and more.

The distance of a market from the producer depends on demand as affected by the cost of reaching that market. This cost is paid wholly by the consumer if the demand exceeds or is equal to the supply; but if the supply exceeds the demand the cost will be paid partly by the producer and partly by the consumer, or wholly by the producer, according to the extent to which supply exceeds demand. It is therefore to the advantage of the producer that such cost is as low as possible. Take the case of maize. The railway rate for export maize is 10s. per ton, and in normal times the freight rate to England is also 10s. per ton. A reduction of either of these rates or both will benefit the producer to the extent of that reduction, if the demand remain the same; and if that demand were in South Africa, the producer would reap the advantage of the elimination of freight and a few minor charges.

It is more profitable to a country to have a market which stimulates greater production than to have one which does not; it is still more profitable to a country to have that market within its borders than outside them. An internal market is under the control of the country itself; and if the products of that country compete with those of other countries they do so under the most advantageous conditions. On the other hand, if they compete in a foreign market, transport charges to the centre of demand may be greater; import duties may be imposed; climatic conditions may be adverse; and even other considerations may militate against the producer's interests.

There are agricultural products which the country can or does raise in excess of its requirements. The production and marketing of such commodities undergo a circular evolution. When production and local consumption balance, prices are stationary. When production tends to exceed local consumption, and prices in consequence recede, an external market is looked for. From an external market follow enhanced prices; from enhanced prices follows improvement in methods of production; from this improvement, greater production from the same area; from such greater production, the same return from a smaller area and the farming of smaller holdings; from smaller holdings, increase in producing population, or closer settlement; from closer settlement, lessening of the cost of production; from cheaper production, the absorption of a larger consuming popula-

tion; from a larger consuming population, greater local demand; and so on until there is effected a gradual transfer of the sale of the product from the external to the internal market. and ultimately the balancing of production and consumption once more. So the economic position which obtained before exportation began is returned to, but there have been gained improved methods, greater production and a larger population, and therefore a stronger State.

(*Read, July 6, 1917.*)

Electricity and Agriculture.—In the course of a paper on "Atmospheric Electricity" in the *Quarterly Journal of the Royal Meteorological Society*,* Lieut. C. D. Stewart, R.E., B.Sc., F.R.Met.S., refers to experiments recently undertaken by Blackman and Jörgensen with a view to further investigation of the possibility of affecting the growth of crops by altering the atmospheric electrical conditions. Two acres of ground were used, one of which was under the influence of the electric discharge, the second being left unelectrified. The former was electrified by 21 parallel wires, seven feet above ground and about 4½ yards apart. The electric discharge was commenced a day after the crop appeared above ground, and one month later the plants receiving the discharge were deeper green in colour and considerably taller than those in the unelectrified area. About six weeks later the plants in the latter area averaged 20 inches in height, while those in the electrified area were 12 inches higher. Eventually the electrified acre yielded a crop of 2,637 lbs. of grain and 4,924 of straw, while from the unelectrified area only 1,764 lbs. of grain and 2,619 lbs. of straw wre obtained. The electric discharge, moreover, leaves a very pronounced residual effect. During the season following the application crops of grass and clover on the previously electrified lands were found to be much heavier than those on lands that had never had an electric discharge. "Although the results are quite definite from the point of view of the crop, nothing is known about the manner in which the discharge acts. It is not even known with certainty what is the most suitable strength of current to use. Why electricity should affect the growth of the crops at all is still quite unknown."

* (1917) **43**, 409-431.

NATIVE IDEAS OF COSMOLOGY.

By Rev. Samuel S. Dornan, M.A., F.G.S., F.R.G.S.

Theories of cosmology are held to be indicative of a fairly advanced stage of thought, and also of considerable knowledge of the natural world. While this is true as a general rule, there are notable exceptions. We have elaborate cosmological theories amongst the Babylonians, Egyptians, and Indians, whose thinking, especially that of the latter, was of a high order. In a still greater degree this may be asserted of the Greeks, though probably their ideas came from the East, as the theories of cosmogony enunciated by Hesiod, and later by Ovid, bear a strong resemblance to the Indian. But we have similar cosmological theories amongst such widely separated peoples as the Mexicans, Zulus, and Polynesians, who, compared to the Greeks or Babylonians, would be classed as barbarians. However widely separated the people who hold these theories may be, from a geographical point of view, their explanations, when closely examined, have several features in common. Not that these resemblances prove derivation from one parent story, but simply that primitive peoples of similar environment think much alike. The idea of creation among the Babylonians was in reality a contest between terrible demons, and the actual fact of creation was merely an episode in that great contest. The gods themselves were but glorified demons, and retained traces of their demoniacal origin long after they had been elevated to supreme power. They only gradually emerged from the demoniacal stage as the consciousness of their worshippers deepened. More and more spiritual attributes became attached to them as time went on. We see such a process in the pantheon of the Greeks, and in the Old Testament there is an immeasurable difference between the apprehension of God in the mind of the prophet Isaiah and that disclosed in the Book of Genesis.

In the case of the Greeks, as late as the time of Pindar, we find the gods accused of cannibalism, and the poet refuses to repeat the slander.* This proves that the Greeks themselves were barbarians and very probably cannibals at no great distance of time from Pindar's day, and that Zeus and other gods had not even then lost all trace of their demoniacal origin. Amongst the Mexicans human sacrifice and cannibalism were common, and had a religious signification. The gods enjoined the practice, and the Mexicans could not understand why the Spanish conquerors looked upon the practice with such horror. Cannibalism as a religious rite is probably not long extinct in South Africa. Where it exists to-day in West Africa and Congoland it has a distinctly religious meaning. Cannibalism was found in Basutoland about 80 years ago, but it was not definitely connected with religion. The people had been driven to it by war and privation.

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* Pindar: "Olympian Odes," I.

The custom of slaying great numbers of young people at the death of a chief or of one of his near relations—as, for example, at the death of Chaka's mother—may be a relic of cannibal feasts.

The peoples amongst whom such practices prevailed had in some cases fairly elaborate theories of creation, and the gods themselves who took part in or, indeed, performed the act of creation were little else than glorified demons. They were beings of limited powers, and of like passions to the worshippers, and so we find theories of creation everywhere contain a large anthropomorphic element. The worshippers conceived of the gods as manufacturing a world as they would have manufactured it themselves. Often the process is ascribed to magical powers. This was so amongst the Egyptians and Babylonians. One characteristic that ancient theories of cosmogony had in common was that the primordial stuff out of which the universe was made coexisted with the gods from eternity. Where it came from or how it originated they did not profess to explain. Apparently they were unable to conceive of creation out of nothing. It was a formless fluid waste, and out it was formed an orderly universe.

The natives of South Africa have their accounts of the creation, and they start in much the same manner that others have started. Creation by word alone is, so far as I am aware, unknown. They did not go so far back as the Babylonians or others. They were not so philosophically consistent. Looking at their explanations from the standpoint of their mental attainments, they do not seem so crude at all. No doubt they were equally as reasonable and as satisfactory to themselves as any of the other explanations. If less picturesque, they are at any rate simple. They do not relate contests of gods or demons. They do not go back to the origin of the visible universe. They assume that such a thing existed, and begin with the creation of man. Thus they are not interested in searching for ultimate causes, and while imbued with the universality of spirits, they had not advanced before the advent of Europeans to the conception of one Supreme Author and Ruler of the Universe, much less of a multitude of such deities. They have spirits in plenty, but they are not gods. They are malevolent enough, but their malevolence is not cosmic, it is tribal or individual, and the immediate aim of the worshippers is to avert this from themselves. As one of the legends of creation that I shall give later on seems to contradict the statement regarding one Supreme Being; all that need be said is that the exception proves the rule. This legend is peculiarly interesting from that point of view, and also raises the question of its derivation from an outside source. The Creation stories current amongst the natives of South Africa do not seem to me to have any religious or even mythological bearings. They are not the property of any priestly caste. They do not figure in the religious observances of the people. Some of them have certain magical implications, but they do not seem to have any connection with demonology as such. The natives do not specifically ascribe the creation of the world to demons, though

much of their religion is demonology. Neither is there any particular trace amongst them of the sort of dualism that is said to prevail amongst the Hottentots, though the Kaffir name for God, Utixo, is a Hottentot word. Amongst the Hottentots Tsuni-IIgoam is the good god, who gives men abundance of sheep and cattle, collects the clouds, and causes the rain. He made all things, and all good things come from him. He lives in a beautiful heaven, all red, while his enemy, Gaunab, lives in a dark heaven, all black. They made war upon each other, and Tsuni-||goam killed Gaunab.* Here we have the old conflict of light with darkness, which is quite unknown amongst the Bantu legends of creation. If the commonly-received explanation of the origin of the Hottentots be right, this dualism must have had its origin in the far North-East of Africa, and is not indigenous.

I shall now give some of the leading stories of the Creation as current amongst the Bantu peoples of this country. They are all, with the one exception noted above, curiously alike. The Basuto version of the origin of man is as follows:—

> Both men and the animals came out of the bowels of the earth by an immense hole, the opening of which was in a cavern, and the animals appeared first. Another tradition, more generally received among the Basutos, is that man sprang up in a marshy place where reeds were growing.†

A Bushman from the Northern Kalahari narrated to me a fuller form of this legend, which he stated he had often heard amongst the Bechuanas. "In the beginning of things, the animals came out in this way, at least, so the Bechuanas say. Near Sechele' town there is a big hole called Lōōwe, which goes down into the ground a long, long way. It is so deep that if you take a stone, and let it drop down the hole, you can hear it falling for a great while, but you never hear it striking the bottom. In this big hole the animals and men were together at the time. But the hole became far too small for them, and they were constantly quarrelling for want of room; each one wanted to get near the entrance, so that he might have a little light. At last they got so angry with each other that the men began to drive out the animals, and they drove them out backwards. Now at the mouth of the cave there was a marsh full of reeds, and the ground was very soft, so that the animals made much spoor, and the place was quite cut up with their tracks. The animals were afraid, and kept trying to get into the cave the first night. By and by they all wandered away. After a while the men began to be many in the cavern, and they, too, fell to quarrelling, and so they drove each other out, and when they were going out, they destroyed the spoor of the animals, so that you cannot see their tracks now, but only the tracks of the men. If you go to Lōōwe, you will see that what I tell you is true." A Bechuana teacher, an intelligent man, related to me another version of the same tale. "Near Linchwe's town is a big cave, very deep. No man has ever seen

* Hahn: "Tsuni-||goam, the Supreme Being of the Khoi-Khoi," 40.
† Casalis: "The Basutos," 240.

the bottom of it, and out of it came the animals and men, because it became far too small for all of them. The animals came out in great numbers first. There were elands, and springbucks, and elephants, and many other kinds, some of which we do not see now in the land. They made much spoor, and they stayed about the entrance of the cave for a long time. The men then cautiously came out themselves, and in doing so they destroyed the spoor of the animals so that you only see their own tracks now. You can only see the tracks of the men at the mouth of the cave." Sometimes an addition is made to the tale in this way: "When the men first were in the cavern they used to hold up with their hands the roof, to prevent it falling upon them, and when they left the cave they used to hold up the sky with their hands to prevent it falling upon them like the roof in the cave. But by-and-by they got very tired of holding up their hands, and they let them fall down, and so people never hold up the sky now with their hands, as they find it will not fall down."

Moffat gives a short form of the Sechuana legend as follows:—

> Modimo (God), as well as man, with all the different species of animals, came out of a hole in a cave in the Bakone country, where, say they, their footsteps are still in the indurated rock, which was at that time sand. In one of Mr. Hamilton's early journeys, he records that a native had informed him that the footsteps of Modimo were distinguished by being without toes.*

Amongst the Basutos the location of this cave is at a place called Ntsuanatsatsi, on or near the Vaal River, where there are three hills close together, but I never met anybody who knew exactly where the place was. Ntsuanatsatsi simply means sun-rising or east, and is the name of the place where the Basutos say they originated themselves. It is therefore very probably a legendary place. Similarly the Bechuanas speak of the cave being in the Bakone country towards Lake Ngami, or at Linchwe's town, or at Sechele's town, but none of my informants had ever seen the place for themselves, so I suspect it is equally as mythical as Ntsuanatsatsi. This tale is very widespread, for a similar one to it occurs amongst the Akikuyu of British East Africa:

> Once there was a great hole with water in it; the water was deep in the centre and shallow at the sides. A man and his wife lived in the shallow water. Then they came out of the water on to the dry land, and journeyed to the Kikuyu country, which was all forest, and had many children.†

It may be asked is the big hole with its water a remnant of the watery chaos in other cosmogonies. I asked the narrators of the Bechuana stories how the animals and man originated in the cavern, or who made them and put them there, or what they were made of. But they could not exactly say, and thought it must have been Modimo (God) who made them. Neither could

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* Moffat: "Missionary Labours and Scenes in South Africa," 262.

† Routledge: "With a Prehistoric People," 283.

they tell whether they were always with Modimo. Of course, where natives have been under Christian influences for any length of time, they unhesitatingly say it was Modimo who made everything. Thus when studying the book of Genesis upon one occasion with a class of young men, one of them said to me that they had a tale of the origin of the world something like that given in Genesis, and then he related to me the following: "In the beginning Modimo made all things, and he made men and women out of reeds, and gave them the animals of the world to feed upon, and they had many children, who became the nations." I asked him if the old people spoke of Modimo in the sense of Creator, but he was not sure. Modimo has the same root as ledimo, a cannibal, but whether there is any connection between the words I cannot say. I have seen no satisfactory derivation of it yet. The idea of water occurs in other cosmogonies such as in the Arapaho and Wyandot mythologies of North America, but these stories do not mention any great hole. In connection with the statement of Moffat that the feet of Modimo were distinguished from the others, by the absence of toes, I may mention that a coloured man resident in Basutoland told me that he had discovered a number of human footprints in rock, not far from where I resided at the time. I had the curiosity to ride over to the place, and found that the said footprints were natural depressions in Molteno sandstone, due to weathering. Some of them looked not unlike the impression of a human foot without toes, and I am inclined to think that a similar discovery was the origin of the Bechuana tale. At Morija, Tsikuane, Qalo, and other places in Basutoland, there are slabs of sandstone and mudstone detached from the cliffs, mostly belonging to the Red Beds of the Stormberg System, containing the tracks of dinosaurs and theromorphous reptiles, some of them of large size. These are fairly numerous, and in the minds of primitive people such as the Basutos, would be just such as would give local colour and verisimilitude to this part of a creation story.

A friend of mine who knows the natives well has suggested that the reeds, stones and cave may have a phallic meaning, but I confess I cannot see any traces of such in any of the creation myths that I have heard. It is quite possible to argue in such a way, but I never heard the natives suggest such an explanation.

The Zulu traditions as given by Calloway are somewhat similar·

Unkulunkulu is no longer known. It was he who was the first man. He broke off in the beginning. . . . We hear it said that Unkulunkulu broke off the nations from Uhlanga; they say he is the Uhlanga from which all men broke off. The old men say that Unkulunkulu is; he made the first men, the ancients of long ago; the ancients of long ago died; there remained those that had been begotten by them, sons, by whom we hear that there were ancients of long ago who knew the breaking-off of the world. . . . . What I have heard is that man sprang from Unkulunkulu, as if he made them, because he existed (before them). . . We have heard it said that Unkulunkulu sprang from a bed of reeds.

There first appeared a man, who was followed by a woman—both are named Unkulunkulu. All things as well as Unkulunkulu sprang from a bed of reeds, everything, both animals and corn, everything coming into being with Unkulunkulu. . . . The earth was in existence first before Unkulunkulu existed as yet. He had his origin from the earth in a bed of reeds. . . . Here sprang up a man and a woman. . . The name of both was Unkulunkulu. . . . On the day the first man was created he said as to what happened then in the bed of reeds, that they did not see their own creation. When he and his wife first saw, they found themselves crouching in a bed of reeds, and saw no one who had created them.*

It will be observed that these accounts, for I have combined several for brevity, are quite confused as to whether Unkulunkulu was before the Creation, or was contemporary with it, or part of it. Some of the narrators seem to think that the earth existed before Unkulunkulu, and that he was the first human pair. I think this is probably the prevailing opinion in the minds of the natives. Such an idea is not confined to the Bantu, but occurs amongst the North American Indians, where people were supposed to have existed in heaven before God and the Devil. Similar confusion exists in the minds of the Namaquas regarding Tsuni-‖goam. I have several times asked natives this question. Since Unkulunkulu came out of the same hole with the animals, was he always there? Did he made the animals himself? My informants were always confused and could not tell. The answer I usually got was: "We do not know, the old people never told us." It may be inferred that the natives do not associate either eternity or omnipotence with Unkulunkulu. There is, moreover no trace in their accounts of the Creation of a struggle between the powers of light and darkness, or of good and evil. I have also put this question: Did Unkulunkulu live in the darkness with the animals in the cave? My informants could not tell. I have also asked how he made the animals. One intelligent native told me he was sure that Unkulunkulu must have had some powerful medicine. This probably represents the average native's opinion of the matter, if he thinks at all. It also imports the element of magic into creation, as among the Egyptians and other peoples, thus showing that it is a primitive explanation of the origin of the world. I cannot see much indication of ancestor worship in the Zulu accounts, although the origin of things is pushed no further back than the creation of one of their own ancestors.

Amongst the natives of Nyasaland and Central Africa, the accounts of creation are generally similar to those given above.

Man, or at least the father of those Central African tribes, sprang from a hole in a rock, from which the lower animals came also. Around this hole were abundant footprints of all kinds of animals. It was closed by the people of Mulungu, and is now a desert place towards the north (Kumpoto). Subsequently to the appearance of man, many changes occurred specially for his benefit. Thus the mist was sent to keep the

* Callaway: "The Religious System of the Amazulu," I *et seq.*

sun from burning up the crops, an arrangement that would readily commend itself to these philosophical children of the tropics.*

At first there were no people, but God and the beasts. There was a chameleon, and he wove his fish trap; when he had woven it, he went out to snare in the river. The day after he went to take it out, and he found fishes therein. He took his fishes to the village to eat them. Again in the morning he went early and found others had entered the trap, and eaten the fishes, and he said: "To-day I have had bad luck. I just found that the otters had eaten my fishes. I do not know to-morrow whether I shall find they have eaten them again." Then he departed to the village, empty, without fishes, and he went to sleep. When it was dawn, he went early again, and found man, male and female, entered into the trap. He said: "To-day have entered things that are unknown. I wonder whether I should take them." Mulungu (God) was staying down here before he went away to heaven. And he said: "Father, behold what I have brought to-day." And he (God) said: "Place them there; they will grow." Man then grew, both male and female. But his father said, "Gather the people together, and call your master." And God was called, and he came and said: "Now, chameleon, where have you brought these from?" He said: "But they have entered my trap." Then God said, "Wait till I call my people," and he went away and called all the beasts of the earth and the birds. They assembled. When they came, their master said: "We have called for those curious beings that the chameleon went to bring in his trap," and all the beasts said: "We have heard,"† . . . .

People came from Kapilimitya (an unsteady soft stone). There came forth two, a man and a woman, and they married and had children. There was seen another man, who was sick, being a leper, who had come from Kapilimitya. The sick man sent the woman to draw water, then he opened a bag and took out maize and millet. On this earth there was no grass, and he said, "You two may sleep in a cave." The sick man died, and the other man put an offering on the ground, saying, "You have left us here, now give us grass." So grass grew and trees; and his children grew and had children; hence the tribe of the Yao.‡

We have here three different and to some extent conflicting accounts of the Creation, and of the relation of God to it. It is also clear that Mulungu is a limited being, just as amongst the Zulus, and does not possess omnipotence or eternity. The tale of the chameleon and the fish-trap introduces the magical element. The Chameleon in many Bantu folk-tales is accused of bringing a lying message to men regarding death, and hence of introducing mortality into the world. This tale may be intended to bring out his wicked conduct in deceiving mankind. The location of the place of origin is no more definite amongst the Yao than amongst the Bechuanas, Basutos or Zulus.

The Damara legend of Creation substitutes a great tree for a great hole, but in essential features it is the same as the others. "The natives in these parts have a strange tale of a rock in which the tracks of all the animals indigenous to this country are distinctly visible, moreover that man and beast lived there in great amity; but one day, from some cause, their deity appeared and dispersed them. . . . The Damaras and Bechuanas have nearly the same notion as to their origin. Thus the latter believe that the founders of their nation and the animals

* Macdonald: "Africana," **1**, 74.
† *Ibid.* **1**, 295.
‡ *Ibid.* **1**, 280.

of the country emerged from a cave, and the former declare that they sprang from a tree. When men and beasts first burst from the parent tree—so runs the tradition—all was enveloped in profound darkness. A Damara then lit a fire, which so frightened the zebra, the giraffe, the gnu and every other beast now found wild in the country, that they all fled from the presence of man, whilst the domestic animals, such as the ox, the sheep, and the dog, collected fearlessly round the blazing brands.

The tree from which the Damaras are descended is to be seen, they say, at a place called Omaruru. But somehow there must be more than one parent tree, for both in going and coming, we met with Omumborumbongas, all of which the natives treated with filial affection."* Galton gives a somewhat similar account in his Travels in South Africa, but says that men have also a special origin or "eanda," and that there are some six or seven of these "eandas," each with its own peculiar rite. Amongst the Nandi† of British East Africa, men and women are supposed to have sprung from the leg of an Ndorobo, a race of hunting savages similar to the Bushmen of South Africa. The Damaras are no more definite in the location of the parent tree than are the Bechuanas or Yao, with respect to their great hole. The darkness in these stories is reminiscent of the Babylonian myth, and raises the question, is there any connection between them? This will be discussed later when considering the derivation of these stories.

I now give a legend of Creation common amongst the Abenanzwa of Southern Rhodesia, who are a remnant of the old Varoswe, whose ancestors claim to have built Zimbabwe and other similar ruins, and who have many curious and interesting customs peculiar to themselves. This account stands on quite a different plane to those given above, and is strangely like that given in the book of Genesis. It runs as follows:—

In the beginning God created the earth and the waters. He saw that the world was bare-looking, and so created the trees, grass, and plants to hide the nakedness. He rested awhile, content, but later on said: "This world of mine is still empty." He then took clay and fashioned beasts, birds, and fishes, and breathing into them, gave them life. He again rested for awhile, and then said: "My world is still not complete. I will make creatures in my own image, and I will call them my children."

God then took clay and fashioned woman, and after breathing life into her, fashioned man and gave him life also. Man, animals, birds, and fishes he fashioned in pairs, male and female, that they might multiply and increase. After this he created no more.‡

Mr. Hemans, who collected this tale from the Abenanzwa, informed me that he had taken the greatest pains to arrive at the truth, that he had cross-examined many natives, with the object of discovering if they had any other explanations, but found none. I may add Mr. Hemans' comment on the religious

* Andersson: "Lake Ngami," 221, 327.

† Hollis: "The Nandi," 97.

‡ Hemans: "History of the Abenanzwa Tribe," Proc. Rhod. Sc. Assoc., 12, [2] 107 *et seq.*

beliefs of the Abenanzwa tribe. They are exceedingly interesting in themselves.

The Abenanzwa believe in a single beneficent Supreme Being, who rewards men for their good actions and punishes them for their evil deeds. After death their spirit leaves the body, and goes to the Mlimo (God) in heaven. Thus all people meet after death, and continue to live indefinitely in heaven. They have no idea of the life hereafter except that it will be a pleasant state of existence. They worship and pray to the spirits of their ancestors. If they have been leading good lives, they believe that the spirits will intercede for them with the Mlimo for the granting of their prayers.

They have not, nor at any time during the history of the tribe have they had, "priests," who conduct religious ceremonies. . . They do not believe in the existence of evil spirits as such, but they do believe that the spirit of one who was their enemy before death will, if possible, do them harm. . . . The religion of the Abenanzwa is thus a monotheism of a simple and rational kind, unmixed with anything in the nature of superstition, and far removed from myths and nature worship. There is a sense of devotion and dependence on a Superior Being.

It has certainly not been taught by white men, as the Abenanzwa have been isolated for the last 100 years (there have never been any missionaries among them), and it cannot have been handed down by their forefathers from the teachings of the Portuguese Roman Catholic Fathers of old, as there exists no trace of any Christian influence.

It does not come from the East, where nature worship prevails, neither is it Christianity from the West, nor is it Arabic (Mohammedanism), as not only do the Abenanzwa believe that the spirit of a woman exists after death equally with that of a man, but in their story of the creation the woman was made first, which is quite opposed to Mohammedan ideas.

Although my knowledge of the Abenanzwa is not nearly so intimate as that of Mr. Hemans, I venture to offer the following observations on these paragraphs. Mr. Hemans states that this legend of Creation could not have been derived from the Roman Catholic Fathers, for the Abenanzwa have been isolated for the last 100 years, and show no trace of Christian influence at the present time. While I am on the whole disposed to agree with him, it must be remembered that derivation from this source is not impossible. The Abenanzwa, according to their own statements, migrated from the neighbourhood of Zimbabwe about 150 years ago. They came by way of Selukwe, and would thus be within reach of the early Portuguese missionaries. The early Dominican and Jesuit missionaries travelled over a large part of Eastern Rhodesia, as far west as Bulawayo at least, and although little or no traces now remain of their influence, still it is conceivable that the upper classes of the old Varoswe may have imbibed a considerable amount of their teaching, and have retained it till to-day, even in distorted and mutilated form. The old missionaries concentrated their efforts on the upper classes, and we read in the old Portuguese chronicles that they made strenuous efforts to convert the King of Mocaranga. Thus some of their teaching must have remained with the people. I agree with what Mr. Hemans has said regarding Mohammedanism. I have not discovered for myself any signs of old Moslem propa-

ganda anywhere in the country, and have not heard of any from others with better opportunities of obtaining information than I have. There may have been some going on amongst the maritime tribes, ever since the Arabs began creeping down the coast, but it never penetrated the hinterland to any extent. I do not think that Mohammedans, certainly the more intelligent of them, would deny the immortality of women, as Mr. Hemans seems to believe. This opinion seems to be unfounded. The mere fact that the obligations of religion rest equally upon women as well as men, proves that, they have souls entitling them to entrance to Paradise. Mr. Hemans also writes of the elevation and purity of the Abenanzwa belief. I think he is mistaken to some extent in this. I have not found such individuals as I have examined in the matter of religious belief so far above the ordinary natives of the country. They are certainly superstitious to some extent. We shall now consider shortly the derivation of these ideas of cosmogony. With the exception of the story current among the Abenanzwa, the others have a fairly close resemblance to each other, and are evidently different forms of one original story. The water and the darkness are features common to other cosmogonic myths of America as well as Asia. Do their indicate, for example, any connection with Egypt in the remote past? This raises the question of the origin of the Bantu themselves. It will be remembered that at the joint meeting of the British and South African Associations for the Advancement of Science in 1905, two papers were read on the "Racial Affinity of the Hottentots," by Prof. F. von Luschan, and on the "Language of the Hottentots," by Prof. Carl Meinhof.* These writers gave strong reasons, both morphologically and linguistically, for thinking that the Hottentots were Hamites, and that their language was Hamitic. That being so, it was probable that they originated in the north or north-east of Africa. Dr. Theal, in his "Yellow and Black-skinned People of South Africa," places the origin of the Hottentots in Somaliland very probably as the result of a cross between Hamites (Egyptians) and Bushwomen.† Meinhof and von Luschan further showed that the Hottentot and Bushman languages were originally quite distinct, that while Hottentot was Hamitic, Bushman belonged to the isolating class of languages with its nearest analogues in the isolating negro languages of the western Sudan. My own investigations into some of the Bushman tongues of the northern Kalahari have, however, led me to the conclusion that originally there was some relationship between the Hottentot and Bushman languages. Von Luschan showed that there were other Hamitic tribes in East Africa, such as the Warunda, Wahyma, and Masai, for-

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* Addresses and Papers, Brit. and S.A. Assocs. for Adv. of Sc. (1905). 3. 111-129.

† P. 60.

merly classed as negroes, while Meinhof stated that certain tribes, the Wahwa and Wasendani, had clicks in their langauges like the Hottentots. How many of these clicks and what they were he does not say. This is interesting of itself, and shows the extent of former Hamitic occupation, and the probable line of advance of the Hottentots. From the Masai, Capt. Merker collected a number of legends relating to the origin of the world, the deluge, the fall of man and others, astonishingly like those related in the book of Genesis. The Masai account of the Creation runs as follows:—

In the beginning the earth was a waste and barren wilderness, in which there dwelt a dragon alone. Then God came down from heaven, fought with the dragon, and vanquished it. From the dragon's blood, which was water, the barren, rocky wilderness was made fertile, and the spot where the struggle between God and the dragon took place was called Paradise. Thereafter God created all things—sun, moon, stars, plants, and beasts, and finally two human beings. The man was sent down from heaven and was called Maitumbe, and the woman, Uaitergorob, sprang from the bosom of the earth. God led them into Paradise, where they led an untroubled existence. They were allowed to eat of all the fruits of the garden, with one exception, called ol oilai. Often God visited them by climbing down a ladder. One day, however, he could not find them, but at last discovered them crouching in some bushes. He inquired what they were afraid of, and the man replied that they had eaten the forbidden fruit. He said his wife had given it to him. The woman answered that she had done it at the suggestion of the serpent. God was angry, and sent the morning star, Rilegen, to drive them out of Paradise.*

I have considerably condensed this account, and it is only fair to add that suspicion has been thrown upon its accuracy. Several ethnologists and travellers deny that the Masai are Hamites, or that these stories are indigenous. Sir Harry Johnston says the Masai are Nilotic negroes, and Hollis, in his book on the Masai, makes no mention of any such traditions. I understand that he takes the view that they are mutilated Christian teaching. However this may be, Captain Merker is in error in describing them as Semites. Hamites they possibly are. But what has the Hamitic question to do with the origin of Bantu Creation myths? The ordinary theory of the derivation of the Bantu peoples is that they originated somewhere west of the Victoria Nyanza, through some negro tribe marrying women of Hamitic type. In that case their language would have been modified by the Hamites, and they would possibly have obtained some of their traditions of Creation from these people. That these is a foreign strain in some of the Bantu seems very probable. Is it Hamitic? I am not thinking of recent Semitic intermingling, such as has been going on along the coast for a long time. Take the old Varoswe of Rhodesia. There are two distinct types found among these people. One tall and slight, with fine straight features, and the other short, abnormally broad and negroid. The former have thin lips, thin noses and flat nostrils. These characteristics may be Hamitic. I do not think

* Merker: "Die Masai—Ethnographische Monographie eines Ostafrikanischen Semitenvolkes." Berlin (1904).

they are Semitic. Speke, in his "Journal of the Discovery of the Nile" speaks of the Abyssinian characteristics of the Wahuma, and we know that the Gallas and old Abyssinians are Hamites. The Abenanzwa may thus very well be a mixed remnant of the old Hamitic stock. Semite and Hamite are very closely related, both in blood and language, and very probably had the same or similar legends of Creation. If so, the Abenanzwa could have derived their like the Masai in this way, and their account is nearest to the original of any in South Africa. The Bantu would thus have carried away from their primeval home these legends, in a more or less complete form. One knows how readily such legends get distorted in the course of ages. Hence the very crude stories that we have to-day are remnants and fragments of a much larger body of legendary lore. Of course it may be argued that there is no connection between Bantu and Hamite in regard to derivation of folk-lore, and that the Bantu ideas of cosmology are purely their own, however crude and primitive they may appear. They are thus an index to the mentality of the people. I confess that this view has a greater attraction for me than the other. However the problem of original derivation may be, the Bantu stories are all different forms of one original, and their very crudity points to a great antiquity. They are thus truly primitive, and give us some light as to how their ancestors thought upon such things as the origin of the world and of man in the remote past.

(*Read, July* 5, 1917.)

A. GORDON HOWITT.—The death in action is announced of another member of the South African Association for the Advancement of Science, Capt. Alan Gordon Howitt, of the East Surrey Regiment, having lost his life in battle on the 5th August. He was at one time a student at the Agricultural College, Aberdeen, and took his B.Sc. degree in Agriculture there some eight years ago. He subsequently joined the German potash syndicate in Berlin, and shortly afterwards came to South Africa as the Syndicate's representative in this country. During his short residence here he frequently contributed articles on the fertilization of the soil to the local agricultural magazines. When war broke out he proceeded to German South-West Africa in the ranks of the Capetown Highlanders, and during that campaign received his commission as second lieutenant. On the conclusion of operations in South-West Africa Lieut. Howitt proceeded to England to join the Imperial forces, and soon won a reputation for exceptional courage. For a special act of bravery he had quite recently been awarded the Military Cross, and was promoted directly from the position of second lieutenant to that of captain.

ORIGIN AND MEANING OF THE NAME "HOTTENTOT."

By Rev. Prof. Johannes du Plessis, B.A., B.D.

The Bushmen, the Hottentots and the Kaffirs are the names under which we know the three great families of natives with whom the earliest colonists came in contact. The first name explains itself, the last is without doubt the Arabic *kafîr* (unbeliever), and was bestowed upon the Bantu tribes of the east coast by the Mohammedan traders. But the name Hottentot is still wrapped in considerable obscurity, and the derivations hitherto proposed have not been wholly satisfactory. In dealing with the explanations that have been offered of the origin of the name, there are some which I think we are safe in rejecting, some which are certainly possible, and one which I venture to suggest as highly probable.

I. Rejected Explanations.

In the "Transactions of the Philological Society" for 1866, H. Wedgwood threw out the suggestion that the word Hottentot meant originally a *stammerer*. "When we enquire how the Dutch would naturally represent the sound of stammering, we find that they make use of the verbs *hateren* and *tateren*, both obviously imitative." He also quotes from the dictionary of Hexham (1647) to show that *hateren* meant to stutter, and *tateren*, to speak with a shrill noise.

Danby P. Fry, in the volume of the "Transactions" quoted above, says that in a Dutch and German dictionary published by Kramer in 1719, he found the word *Hortentot* in the sense of a stammerer, "and this," he adds, "may be the word referred to by Dapper." He also adduces the authority of Judge Watermeyer, whose words are: "Dapper asserts that a word like *Hottentot* was a word in ordinary use in Holland in his day to signify stammerer. . . . Dutchmen themselves would not believe it to have been a word in use in Holland before it was applied to the South African natives, but for the conclusive evidence of such a passage as this in Dapper."

Dr. Theophilus Hahn, again, in his "Tsuni-Goam," supplies us with another suggested derivation. "On account of their curious language, abounding in harsh faucal sounds and clicks, the Dutch called them Hottentots. Hottentot, or Hüttentüt, means in Frisian or Low German a quack; and therefore the old Dutchmen, who were so much puzzled and did not know what to make of such an unheard-of language, more akin to the chat of a parrot than to human speech, called it *Hottentot, i.e.*, mere gibberish" (p. 2). In support of this view he quotes the *Idioticon Hamburgense* (1755): "Hüttentüth, Schimpfwort auf einen unnützen Artzt, welcher beim gemeinen Mann heisset: 'Doctor Hüttentüth, die den Lüden dat water besüht'" (p. 32).

I feel that I, for my part, cannot accept these ingenious explanations. My first objection is this, that the men who were the earliest visitors to our shores were not learned philologists, who could put words like *hateren* and *tateren* together and coin a new word; nor would it occur to them to apply to the dirty and thievish natives a name that was opprobiously used to designate a quack. They were rough sailors, who would be likely to designate a strange people by some striking characteristic of custom or speech, and most probably in some imitative term. My other objection to the proposed explanations is that they place the cart before the horse; in other words, they explain the more ancient by the more recent, instead of *vice versa*. *Hortentot* in the sense of a stammerer, and *Hottentot* in the sense of a quack, are not the origin of the name as applied to the Cape natives, but are to be *explained from* the latter. In the second quarter of the seventeenth century the word Hottentot must have been quite a well-known designation for the Cape *strandloopers,* since van Riebeeck, in his "Dagverhaal," constantly uses it without explanation. The dictionary of Kramer, on the other hand, and the Idioticon Hamburgense were only published in the eighteenth century. The conclusion is plain, that the word Hottentot had by that time become so common that it was used to designate a stammerer in Holland and a quack in Germany; just as to-day it is used as a *schimpwoord*, or term of opprobium, in Cape Dutch.

Let me now pass to the

II. Possible Explanations.

The French missionary, Arbousset, travelling through Central South Africa in 1836, says of the language of the Hottentots that it is harsh and broken, and uttered with strong aspirations from the chest. "C'est comme si l'on n'entendait jamais que *hot en tot*. Aussi n'est-ce pas sans raison qu'on a dit d'eux qu'ils gloussent comme les dindons." ("Relation d'un Voyage," p. 480.) This is, of course, nothing but the old onomatopoetic derivation that we find very commonly in the books of the earliest travellers.

Wouter Schouten, who visited the Cape in 1658 on his way to the East Indies, says in his "Reys-togten"* that the Hottentots are

> Wilde menschen, die haer langs strant met heele troepen aen ons vertoonden. Deze worden Hottentotten, wegens haer klokkende spraek, die naer het geluyt der kalkoense hanen gelijkt, bij ons en ook andere natien genoemt. . . . . Zij worden van wegens haer wildheyt en klokkende spraek, die al hakkelende ver uyt de keel schijnt voort te komen, gewoonelijk Hottentotten genoemt."

The language of Dapper on this question deserves to be quoted in full, for upon his remarks not a few theories have been built, for which (to my mind) Dapper cannot be legitimately appealed to as authority. His "Afrika," which appeared in 1688, has the following upon the speech of the Hottentots:—

* 3rd ed., **1**, 8, and **2**, 182.

Hun sprake gaet geduurigh met klokken als de kalkoensche hanen, klappende of klatzende over het ander woort op hun mond, gelijk of men zijn duim knipte, zoo dat hun mont bijna gaet als een ratel, slaende en klatzende met de tonge overluit: zijnde elk woort een bijzondere klats. Zommige woorden weten zij niet dan met heel zwaere moeite te uiten, en schijnen die als van achteren uit de kele op te halen, gelijk een kalkoensche haen; of als de luiden in Duitslant aen d'Alpen doen, die door het drinken van sneeu-water kropzwellen aen den hals krijgen: waerover d'onzen hen ten opmerke van deze belemmering en ongehoorde hakkeling van tale den naem van Hottentots gegeven hebben, gelijk dat woort in dien zin gemeenlijk schimps-gewijze tegen iemant die in het uiten zijner woorden hakkelt en stamelt hier te lande gebruikt wort. Zij noemen nu ook zich zelfs met den naem van Hottentot, en zingen bij d'onzen al danzende *Hottentot brokwa, Hottentot brokwa*: waer mede zij willen zeggen, geef Hottentot een brok broot" (p. 652).

The question here is what Dapper really means by the sentence "gelijk dat woort in dien zin gemeenlijk schimps-gewijze . . . hier te lande gebruikt wort." Does he mean that, since the word Hottentot was known in Holland as a term of opprobium for stutterers, it was applied to the Cape natives on account of their clacking speech, or does he mean that the word Hottentot, connoting as it did a clacking speech, was in like manner ("gelijk") applied to stutterers in Holland? I am of opinion that the conjunction "gelijk" in the sentence quoted does not give a reason, but merely introduces an illustration. And I am upheld in this view by Dapper's own admission, confirmed among others by Kolbe, that the Hottentots originally called themselves by that name, or in some manner made use of a name or expression resembling the word *Hottentot*. So that, though I do not wholly reject the onomatopoetic explanation, I venture to submit evidence for a more

III. Probable Explanation.

Before I produce my evidence I wish to call particular attention to the fact that in the Dagverhaal of van Riebeeck, the Cape natives are consistently called *Ottentoos* or *Hottentoos*, the singular being *Ottentoo* or *Hottento*. In only one place have I found *Hottentot* as the designation of a single individual (namely in Jan van Harwarden's Journal, February, 1658), and this spelling is so rare that I suspect a misprint. Moodie has the following footnote (*Record*, p. 331):—

About this period (September, 1673) the present termination of this word (*i.e.*, Hottentot) began to take the place of the former (Hottentoo) —evidently from the necessity of introducing consonants to form the Dutch feminine Hottentottin.

Here, then, we have important evidence, which takes the bottom out of the theories of onomatopoetic derivation: the original form of the name was not Hottentot, but Hottentoo.

There is, however, one piece of evidence which points in the direction of an earlier form ending in *t*. Sir Thomas Herbert visited Table Bay in 1626, and he has the following sentence: "Only upon their feet (he is speaking of the natives) have they a sole or piece of leather tied with a little strap, which while

these *Hatten-totes* were in our company their hands held, their feet having thereby the greater liberty to steal." This seems to be decisive for the early use of the consonantal ending. But is it? My copy of Herbert is "the Third Edition, further enlarged—London, printed in the yeare 1677." I have not had access to a First Edition, but I should not be at all surprised to find that the "*Hattentotes*" only appeared upon the scene in later editions, when the word itself in the newer etymology had already found a footing.*

Now with reference to the origin of the name, I shall quote a sentence or two from travellers during the late seventeenth and early eighteenth centuries. Père Tachard, in "A Voyage to Siam," undertaken in 1685, says: "The first nation in the language of the country is called Songuas (*i.e.*, Son-quas). The Europeans call those people Hottentots, perhaps because they have always that word in their mouth when they meet strangers" (*op. cit.*, p. 68). The Rev. J. Ovington, who was here in 1689, says: "They retain the vulgar name of *Hotantots*, because of their constant repetition of that word in their hobling dances." ("A Voyage to Suratt," p. 489.) William Dampier called at the Cape in 1691, and gives the following account of the name Hottentot: —

> The natural inhabitants of the Cape are the *Hodmadods*, as they are commonly called, which is a corruption of the word Hottentot: for this is the name by which they call to one another, either in their dances or on any occasion, as if every one of them had this for his name. The word probably hath some signification or other in their language, whatever it is.†

To the same effect, Francis Leguat (1698): ". . . the natives of that Province, whom the Hollanders called Hottentots, because they often hear them pronounce that word" ("Voyage to the East Indies," p. 226); and Captain Beeckman (1704): ". . . they are called by that name from their frequent repetitions of the word in their dancings" (quoted in *Mendelssohn*, **1**, p. 108).

To the evidence already adduced may be added that of Kolbe, who, in his account of the Hottentots, leans upon and is backed by the far more powerful authority of the learned Secretary Grevenbroek. Kolbe, then, after quoting Tachard, refers to the opinion of Mercklin in his "Oost-indische Reisbeschrijving," who says of the Hottentots "dat zij, vrolijk zijnde, gestadig op en neer springen, en het woord *Hottentot* daarbij zingen . . . weshalve zij ook van de Hollanders in 't gemeen Hottentotten genaamd worden" (Kolbe, "Naauwkeurige Beschrijving," **1**, 415)

We see then that the earliest evidence strongly favours the supposition that the name Hottentot was not a term imposed upon the Cape natives, but a term derived from them; and that the word had some connection with their ceremonial dances, and

* This I have since found to be the case. In the first edition of Herbert the natives are not called by any proper name at all.

† "Voyage round the World," 7th ed., **1**, 539.

perhaps also with the greetings they employed towards each other and towards strangers.

I must now return to van Riebeeck's Dagverhaal—that still unexplored mine of information on the first ten years of the Settlement. On the 7th September, 1655, Corporal Willem Muller proceeded on an exploratory tour inland, accompanied by the Hottentot interpreter Harry. At a spot which cannot have been very far from Capetown, in the direction of the Cape Flats, they observed something which drew their attention, viz., "a strange proceeding of the Hottentot women, on the side of the path, where a great stone lay. These women went together each with a green branch in her hand, laid down upon their faces on the stone, speaking some words which we did not understand. We asked them what it meant, on which they said *Hette hie,* and pointed above, as if they would say, 'It is an offering to God'" (translation by Moodie, *Record,* p. 72).

Dr. Theophilus Hahn at once seized upon the importance of this little bit of information, and made the following comment on it: "As will be seen from the sequel of this chapter, the word *Hette hie* is only a distortion of *Heitsi-eibib*, and the form of worship described here at the cairn is nothing else but the Heitsi-eibib worship as it is practised to-day all over Great Namaqualand, etc." ("Tsuni-Goam," p. 36). I wish, however, to take the step which Dr. Hahn stopped short of, and to suggest that *Hette hie* was the expression which the early settlers heard so constantly from the natives, and from which they nicknamed them *Hottentoos*. I grant that the resemblance of *Hottentot* to *Hette-hie* is not philologically perfect, but if we remember that the last "t" is an addition of later date, and that the early sailors did not profess to give an exact reproduction of the native word, but only to coin a word that resembled it, the similarity must be admitted to be sufficiently close. At any rate, the proposed identification meets three conditions of the problem which, if we are to believe the words of the old travellers, must necessarily be observed: (*a*) the name Hottentot must be shown to be derived from, and not imposed upon, the natives of the Cape; (*b*) it must be a word that was uttered in connection with their ceremonial religious dances; and (*c*) it must be a word which could be employed in friendly greetings. These conditions are all fulfilled in the proposed derivation from *Hette hie*.

(*Read, July* 4, 1917.)

RUBBER FROM CARBIDE.—The *Journal of Industrial and Engineering Chemistry** draws attention to the present importance to Germany of the manufacture of acetone with a view to the production of synthetic rubber. Some of the largest German firms have been occupied with this problem, and there are now firms in Germany producing 10 to 50 tons of calcium carbide per day in order to convert the acetylene into acetic acid and acetone, the latter being intended chiefly for the production of synthetic rubber.

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* (1917) **9** [10], 984.

THE NEED AND VALUE OF ACADEMIC STUDY OF NATIVE PHILOLOGY AND ETHNOLOGY.

By the Rev. W. A. Norton, B.A., B.Litt.

The School of Oriental Studies was recently opened in London by the King-Emperor. Here is an extract from the speech of His Majesty:—

"If the school happily succeeds in imparting to the pupils, sent out as teachers of unselfish government and civilised commerce, a clearer comprehension of the thoughts and lives of the diverse races of the East, the good effects of that success will extend far beyond the immediate and tangible results."

These words may certainly be applied to ourselves in Africa, where we need indeed, as a nation, all the help we can get from the sciences.

Enormous strides have doubtless been made in the application of science to the more material side of our civilisation, but how backward we are still in the endowment of research, in the intelligence departments of our work, both in war and peace.

I need not labour the proof of this statement. Constantly we read in the war news that the greatest bravery was shown, but there was something lacking in the staff work. Of course, it is easy to say this. Unfortunately it is also hard to deny it. It is not the fault of the staff officers so much as the fault of the whole trend of English intellectual life, and want of thoroughness on the intellectual side of our public education.

Let me quote some words from "The Great War" on the lack of sufficiently high explosives at the Dardanelles.

"This condition of affairs was due to the fact that our military authorities before the war broke out were unable to get as good a fuse for high explosive shells as the Germans possessed. Either through a total failure of the scientific intellect of our Empire, or through the neglect by the Government to put the problem of high explosive shells into the hands of men of science capable of solving it, our shell remained inferior to both the French and German shell."

I add one more quotation: "It is time England emerged out of the old insular order of ideas into one of greater intellectual grandeur and more universal concern to mankind." This lesson in many ways is being learned.

It is strange that this insularity should touch us in this sub-continent; but as a missionary and a citizen of South Africa, I for one cannot but deplore in particular the amazing want in the past of scientific interest in that great asset of the Union, the native races. The old fallacies are repeated year after year, the old grumbles day after day, but any real grappling with the problems of race which go deep down into our social polity are few and far between indeed.

And no wonder—for with the multitude of academic estab-

lishments with which South Africa is blessed, we have nothing, practically, in the way of endowment of research into matters native; and while a certain number of men are vaguely known as successful with groups of natives, there are very few serious students in South Africa adequately equipped philologically and ethnologically, who can guide us to anything like a wide view of the Bantu races, notwithstanding the fact that their coherence in the main invites workable generalisations. I see that now,* after being talked about for 70 years, a chair of Bantu Philology is being advertised in connection with the new Cape University. This is a healthy sign of change in this respect.

Unfortunately, it is not alone the State which is to blame in this neglect of research into native matters—a study which in the past (and possibly in the future) would have amply repaid us for any outlay it had cost by the avoidance of misunderstandings and outbreaks.

But missions as well, though in their poverty they may rightly look for aid, on the academic side, to South African Universities; have not done, and are not doing, what they might. It is not necessary that every missionary should be a linguist, but it is necessary that he should study the tongue of his people, because it is the best index to their psychology. At present I fear that a large number of us missionary clergy cannot even read intelligibly in the native tongues. Boards of Missions have recommended examination in them, but this seems often to be a dead letter.

As an example of the ill-effect of this neglect of language study, I may mention that in some of our books the third article of the Creed is still translated as though the Holy Spirit were the Mother of Christ, while the most extraordinary mistakes are made through interpreters, of which I could give startling examples. Let me illustrate these remarks from my own experience. I listened to a dignitary of the Church deliver an excellent sermon on the married state, which was interpreted into Sesuto. The text was "Bear ye one another's burdens"; the interpreter said, "Preserve one another (bolokana)." "It is the duty of the man to bear the burden of the wife"—interpreted "to preserve the wife (boloka)." "And it is the duty of the wife to bear the burden of the husband." Now, the interpreter could not think it the duty of the wife to keep an eye on her husband, and his mistake dawned upon him: "It is the duty of the wife to carry the parcel of her man on her head" (ho roala liphahlo tsa monna oa hae!). Here you had, not the Christian mutuality which was the point of the sermon, but the age-long relation of the native man and wife: the man keeping his eye on the womenfolk behind, toiling along with his impedimenta. I mentioned this to the preacher afterwards, and it seemed to cause him some of that "agony of mind" of which Dr. Moffat speaks when he

* This was in July. A new year has come, and no appointment has yet been made.

says:—"Trusting to an ignorant and unqualified interpreter is attended with consequences, not only ludicrous, but dangerous to the very objects which lies nearest the missionary's heart. Since acquiring the language" (Secoana, in his case) "I have had opportunities of discovering this with my own ears, by hearing sentences translated, which at one moment were calculated to excite no more than a smile*, while others would produce intense agony of mind, from their bordering on blasphemy, and which the interpreter gave as the word of God."

But it is not only training in philological studies that is necessary. The life and customs of the natives need much deeper and systematic study, the pigeon holes of which should be provided, and the elements acquired, before the worker ends his academic training in England or elsewhere. Many a fatal mistake, not only in dealing with individuals, but also of general policy, might have been avoided by a grounding in ethnology and comparative religion. This last is now receiving attention in theological and missionary colleges,† and one is glad to find that a mission working on the Rand sends up some of its men for a training in phonetics, the science which is the doorkeeper to modern philology. But almost everything remains to be done; I speak of scientific preparation.

We need, then, a fuller use of all that science can contribute to our work, and especially (surely) in the highly technical business of missions to heathen, whose languages and customs, so remote from our own—though much allied to those of Bible times—demand all the consideration the Church can afford them, and all the encouragements to adequate scientific study which we, both in State and Church, at present so generally neglect.

I always feel that we should increasingly decline the services of untrained men, just as we would those of a non-first-aider in an accident. Some seem to think that religious zeal makes up for training, but it will not be those who are fated to suffer the experiments of such practitioners. I also hope to see our students boycott those missions which require no adequate training, and probably will not fail to waste their labour

For the encouragement of such studies provision should be made. South Africa is teeming with University Colleges, supported by the State, but I submit that no University is worthy of that august name which does not make provision for the study

* One is reminded of the Natal lady who left out the click of *amaqanda*, and was brought, not the *eggs*, but the *heads* of her fowls.

† As a writer has written in "The East and the West," in regard to the work of missions: "No man can talk reasonably on religious questions with other men until he knows their religion. How can he stand before the people and speak to them in a brother's tone about their religious life, unless he knows what they believe? It is impossible to form a reasonable estimate of the influence of a religion and its value for those who follow it without careful study. In conversation and in addresses the man without knowledge says a hundred unintelligent things which wound his audience without his realising it." Native religion is largely folk-custom, which therefore needs study, with the help of comparative ethnology.

of the people within its own part of the world and their psychology (as exhibited chiefly in their languages).

Something has been done from the ecclesiastical side to overlook the linguistic *progress,* in the narrowest sense, of our missionaries. This should have been done long ago, and it is but the minimum still. Little indeed is done to aid the *training,* and almost nothing is known of the scientific side of Bantu languages *comparatively,* in spite of the interminable talk of our synods and conferences. What is wanted is study, and therefore specialists, not talk of the promiscuously interested—or uninterested. But the scientists have little right to blame, for they also have done nothing in the matter (and it is also their business), in spite of interminable talk in science congresses, and even Parliament, about the necessity of research.

I complain of us ecclesiastics more especially, because while laymen think it only becoming to offer the homage of lip-service to the need of research, the clergy is apt to regard these interests as idiosyncracies of the few of their number who have any appreciation of the importance of them. They do not realise that they are a necessary condition of effective work with the more primitive peoples. Even among civilised peoples closely allied it must be so. How would a Frenchman fare who should preach to English folk without a working knowledge of English customs, habits, or language? Or how would an Englishman so situated fare with Dutchmen? Little research is needed here, but with a psychology so remote as that of our natives, it is otherwise.

Of course, those who propose (so obvious yet, as it seems) so strange a view, must expect neglect and some derision. In my early days in Devonshire, the pioneer diggers in Kent's cavern were considered mild lunatics; yet they were the pioneers of modern English ethnology. Even Livingstone was asked why he left the preaching of the Gospel and devoted himself to exploration. He answered that the end of the geographical problem was the beginning of the evangelistic opportunity.

We need now an explorer of another kind, who shall re-read, in the originals, the old Arabic, Portuguese, Dutch, and English geographers and travellers, in the light of what is now known from *native* sources.*

South Africa should have chairs of Bantu Philology and Ethnology (dealing with folk-lore and customs, tribal history, wandering of peoples, music, star-names, etc.), because she alone can do justice to these subjects. What should we think if India had done no research on Indian ethnology or philology, or America on her failing red men, or (shall we say) South Africa on her special botany or geology. But these sciences fill pockets. So also would better understanding of the native, if only men would see far enough, or Governments beyond the next election. It might be said that these are more important,

* I may illustrate from a passage in Mas'udy, where the French translation makes him give *waklime* as the "Zeng" name for chiefs. This is doubtless a misreading (*qaf* for *fe*, differing by a dot) for Swahili *wafalme*.

but the Bantu languages are considered by the students of them to be likely to throw great light on general philology, and Bantu folk custom is highly developed. At present the study of them is largely left to Germans, and their books are published by their Government. We have published almost nothing but translations of Meinhof, because there is no public; nor will there be one, until the Universities take up the work which is done in Germany by the Kolonial Institut and the Orientalisches Seminar. With the long-belated London School of Languages, we are at last waking up. That school has a reader in Swahili, etc.; Africa itself has nothing. Surely she can afford *one Chair* for *all* sciences connected with the major part of her population!

Here are some of the lines of *research* which *urgently* need doing, for every month some old man dies, with whom also dies all reliable information about some branch of native lore or history:—

(*a*) Native philology proper: comparative phonetics (the basis of all), comparative vocabularies and etymology, comparative syntax, and general grammar. ;

(*b*) Grouping of dialects; a work largely phonetic, and at present very problematic. The field is open for South African workers.

(*c*) Relation of Bantu to Hamitic, especially the Hottentot on the South and Masai on the North; to Sudanese languages on the North-East; and to Bushman and other pigmy dialets.

(*d*) Special lines of research leading to the solution of ethnological, prehistorical, historical, and social questions; *e.g.*, star-names, native music and poetry, tribal and local and family history (*e.g.*, of chiefs); such subjects have the widest bearing on general ethnology and the special folk-wanderings of Africa.

(*e*) Native psychology, which mainly can be learned through language only, and is so valuable a guide in the administration of native areas, Union natives, native education, mission work, etc. Our native troubles have largely come about through our not understanding the psychology of the people. We cannot rule or use a people, not to say educate them, if we do not know their psychology. Study of peoples' languages and customs would have saved many a punitive expedition.* In Nigeria, as I heard from an official, the Government discouraged mission work till an ethnologist should be found for it, and I am not at all sure

* *Cf. Cape Times*, July 1, 1917, on Mandume, in the North of S.W. Africa: Natives recognise no artificial boundary lines ruled on the map by the white men, dividing a tribe. Here was another instance of an arbitrary boundary created between the Portuguese and Germans without reference to ethnological considerations—one of the most fruitful sources of trouble in Africa since the advent of civilised governments. Mandume could never fully appreciate the restrictions preventing him from going across the border to punish some wrongdoer, or some refractory headman intriguing against him.

they were not right. The Navy gives a bonus for languages, and the Indian Civil Service encouraged these studies; why not South Africa?

In the way of language *teaching* we need—

(*a*) Advanced lectures, stating problems and needs, and summarising results; these for the learned and for the scientific guidance of legislators and administrators. These would not touch party politics, for that would spoil the essentially unbiassed search for truth, which should characterize academic work, but would nevertheless help legislators as agricultural science helps farmers.*

(*b*) Popular lectures and University extension lectures, calculated to enlighten public opinion about native matters, like Meinhof's lectures at the Kolonial Institut of Hamburg.

(*c*) Teaching of students of two sorts—(i) those wishing to study this branch of philology, either for its great assistance to general philology, or for the light it throws on South African problems.† This will gradually raise up a South African school of the philology of her peoples of the lower culture, still living and growing; (ii) those wishing to learn individual native languages, *e.g.*, administrators, doctors, missionaries, students of native lore and custom (now greatly on the increase), traders, and others.

I heard the other day of a railway constructor who could find no one to guide him to the tongues of his boys at railhead.

For this purpose we need to have a few selected specimens of native tribes, and instruments to phonograph their speech and singing, *i.e.*, a phonetic laboratory, as again at Hamburg. One who knows the native would not find this expensive; they would be his houseboys, glad to speak their languages for the behoof of his pupils rather than do house-work; natives not educated are better usually for this work. Teaching should be given by means of the living voice of these natives, but only a comparative phonetic student of Bantu can successfully teach thus.‡ Capetown, with its port and docks and location, is a very good centre for this work, and might become, for philological purposes at least, a Hamburg of South Africa. The Government and mis-

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* Governments which have no time nor money for ethnological research, should have lived in the day when farmers never dreamed that chemical research could affect them.

† *E.g.*, philology reveals much about the fauna and flora of early Africa.

‡ While the teaching of languages is being revolutionized in Europe by the use of *phonetic method*, it is deeply disappointing to be greeted by some missionary to-day with the Suto greeting (for example) pronounced "Dumeyla moreyna," whereas anyone with a careful ear can discover that the "e's" of "Lumela Morena" are broad. How we should laugh at a man who said :"Let me tail you something: there is a lion roe-ring in the back yard." Yet we expect our poor natives to understand our continual and worse mistakes.

sionary societies could be asked to draw the attention of their agents to such a language school, and a bonus should be given by them for knowledge of native dialects and lore. Government should also afford facilities for travel to some research worker in Bantu. A man phonetically and philologically equipped can do in a few weeks an immense amount of work from some native centre.

A South African University is alone capable of studying this branch of philology, growingly recognised by the few experts as most important for general philology (owing to the unity of the group, the unexpectedly logical character of the grammar, and the surprising confirmation often given to the hypotheses of Aryan philology), not to mention its enormous importance for the due consideration of practical native problems. The hindrance of the war does not apply to this specially South African subject; it rather helps by gathering contingents drawn from various tribes. The science is new to English and Dutch-speaking people, as to most, and we have a splendid opportunity for developing studies which have hitherto been almost a monopoly of Germany and her Colonies, as shown in the use she has made of her native material in East Africa.

Work at King's College, London, and at Cambridge and Oxford, has been done in these subjects; and it is absurd to have a University in South Africa which ignores the language and custom of five-sixths of her population, while it has, for example, (very rightly) a Chair of Hebrew. The delay due to the war is the opportunity of getting this subject its due place while there is still time. The neglect of Bushman relics, and of the treasures of folk-lore which explain them, is felt by many as a permanent disgrace to South Africa, and a failure to pay her unique contribution to the interpretation of primitive art, and to the philology of a most interesting group of *dying* languages; but the Bantu, and their language and psychology, form a *living*, instant and most practical problem, to the solution of which we, alone able, are contributing very little scientifically, or perhaps otherwise! We need no *mere* scientists to deal with it, but those in living touch with the native. On the other hand we do not want *mere* administrators or missionaries, even if they may know several languages, but those who will exhibit the laws of development and correlation of those tongues with one another, and with the lives and customs of the people; and we need, under the guidance of specialists, more and more enlightened co-operation between different workers in Government administration and missions of all denominations in the various fields, to provide material for scientific research and to apply the result to the best advantage of religion and of the State.

In connection with this paper, may I be allowed, by way of illustrating its statements, to refer to my former papers before this section:—Puberty Rites, Early Geography, Bantu Philology and Primitive Life, Star-names, and Music and Folk Custom (all 1909), Study of African Languages (1914), Melodies (1915), Place Names (1916)?

AGRICULTURAL EDUCATION IN SOUTH AFRICA.

By Prof. Abraham Izak Perold, B.A., Ph.D.

Historical.—It was in the year 1887 that the first courses of instruction in Agriculture were given in South Africa. They were given by the late Professor Blersch, at the School of Agriculture and Viticulture at Stellenbosch, with the assistance of the Victoria College authorities, who also initiated the scheme. Professor Blersch's untimely death in 1897 meant a great loss to the teaching of this subject. He had then practically completed his "Handbook of Agriculture for South Africa," which was published after his death in 1906 by Mr. J. H. Overman, of the Government School of Agriculture at Somerset East, now no longer in existence. This posthumous work of the much-regretted pioneer in the teaching of Agriculture in South Africa should prove of great value to farmers and students of agriculture alike. Unfortunately, and I use this word advisedly, the Cape Government removed the seat of this Agricultural School to Elsenburg early in 1898, thereby separating the teaching of agriculture from the higher education offered in the different Arts and Science Departments of the Victoria College. This step would probably never have been taken if it had not been for the unfortunate fact, that the Agricultural School was then under the control of the Agricultural Department. Subsequently the Elsenburg School of Agriculture was handed over to the Education Department, but was later on again transferred to the Agricultural Department, where it has remained ever since. Why this was done I cannot say, but I consider it was a wrong step to take. Had Elsenburg remained under the Education Department we should by now probably have found more agriculture taught in our primary and secondary schools than is unfortunately the case at the present time.

Under the Crown Colony Administration in the Transvaal subsequent to the Anglo-Boer war, a first-class School of Agriculture and Experiment Farm was founded at Potchefstroom, and very ably organized by Mr. Alex. Holm, now Under Secretary for Agriculture (Education). Before Union a second School of Agriculture was established in the Cape Colony at Grootfontein, near Middelburg. Also at Cedara, in Natal, a similar school had been established, and just prior to Union the Orange Free State Government decided to establish such a school in the Orange Free State. At the date of Union there consequently existed the four Schools of Agriculture at Cedara, Elsenburg, Grootfontein, and Potchefstroom. Since Union a fifth Agricultural School has been established at Glen, near Bloemfontein. At present, therefore, we have five such schools, although the one at Glen is not yet in full working order.

The latest development in our agricultural education has been the founding of the two Agricultural Faculties at Stellen-

bosch and Pretoria respectively. These will be integral parts of the Victoria College (the future University of Stellenbosch) and the Transvaal University College, under the future University of South Africa. The year 1917, therefore, saw the final steps taken for the teaching of Higher Agriculture in South Africa. This brings my brief historical sketch right up to date, so that I shall now turn to the next phase of my subject.

Present Facilities.—The subject of Agriculture is practically not to be found in the curricula of our primary and secondary schools. A litte Nature Study and Agricultural Science are taught here and there, but that is all. The present facilities for the teaching of Agriculture in the Union are therefore practically only such as are offered at the above-named Schools of Agriculture, which are at the same time also Experiment Farms. Here the following courses of instruction are offered: —

(1) *Diploma Course,* covering two years, with Standard VII as standard of admission;
(2) *Honours Diploma Course,* which is an extension of the Diploma Course by a third year, and is open only to Senior Certificate and Matriculated men who have done well in their Diploma Course;
(3) *One Year Course,* with Standard VI as standard of admission, and previous farming experience;
(4) *Short Courses,* during the winter vacation (consisting of two courses, each lasting 2-2½ weeks), and at Elsenburg an additional Short Course on Wine-making in January, lasting one week.

To these short courses both ladies and gentlemen are admitted, whilst only men are admitted to the other courses. Since the beginning of this year, however, the long courses for men have been discontinued at the Cedara School of Agriculture, and a course for ladies substituted, lasting four and a half months. This course is given twice every year. As about 40 ladies entered for the first course, which has now terminated, it proves that this innovation met with the success it deserved and fulfilled a much-felt want.

Details may be obtained from the Principals of the different schools, but I propose giving here some information which should be generally useful.

The instruction at each school covers practically every branch of farming in the Union, and every student must take the full course, except in the Honours Diploma Course, where the students can choose one major and two minor subjects. The subjects of Viticulture and Wine-making are taught only at Elsenburg. The elements of Viticulture only are given at the other schools under Horticulture. The subjects of instruction at these schools are: Animal and Field Husbandry; Elementary Botany, Chemistry, Geology, and Zoology; Agricultural Botany, Chemistry, and Zoology; Veterinary Science; Entomology; Poultry Husbandry; Dairying; Agricultural Engineer-

ing and Building Construction; Agricultural Law and Economics; Horticulture; Viticulture and Wine-making (at Elsenburg only). Further Carpentry, General Blacksmithing and Horse-shoeing, and Harnessmaking are taught as purely practical subjects.

The instruction is both practical and theoretical, more than half the student's time being devoted to practical work. The only exception is in case of the one-year men, who get mainly theoretical instruction. They must take most of the lectures of the first and the second year men, and get only a relatively small amount of practical instruction, as they are supposed to be well acquainted with practical farming when starting on their course. These courses of instruction are eminently suitable to those of our future farmers who do not wish to carry their studies in the secondary school to the Matriculation or Senior Certificate examination with a view to taking a somewhat similar course at one of the newly-founded Agricultural Faculties mentioned above.

I have some criticisms to offer on the courses of instruction as at present given in our Agricultural Schools, but these I shall bring forward towards the end of this paper. With reference to the Short Courses of instruction given at our Agricultural Schools I wish to state that the subjects for each course are so chosen as to serve best the grain and stock farmers in the first course, and the wine and fruit farmers in the second course, certain subjects being given in both courses. These courses are excellent for those already farming who cannot get away from their farms for more than 2-4 weeks at a time. Further, they offer an excellent opportunity to teachers and the general public for getting an insight into the principles and practice of farming in South Africa. For this reason one of these courses (usually the second) is always so arranged as to fall in the vacation of our public schools. These courses are much better patronised than the one and two years courses, and they are becoming more popular year by year.

To the above I must add that the lecturers at these schools do much extension work to educate the outside public by means of correspondence, lectures, demonstrations, and personal visits. All these schools are fairly well equipped, have fairly complete and well-trained staffs, and stand under the able and energetic departmental control of Mr. Alex. Holm, the Under Secretary for Agriculture (Education).

Present and Future Needs.—In a country like South Africa, where Agriculture is the main industry of its people—I say this without forgetting or underrating the importance and usefulness of our great mining industry—properly trained agriculturists, and many of them, are a primary need. In a country like our own, where long droughts and numbers of dangerous stock-diseases are to be counted amongst the farmer's more or less permanent enemies, this becomes all the more imperative. Whilst farming is the oldest profession of man, it is bound also to last as long as men will live upon our planet, and it will always continue to

exercise a great attraction on large numbers of men and women in every well-regulated society. There is certainly no more healthy calling than that of the farmer, and we should make it our business as a nation to strengthen the hands of tillers of our soil and rearers of our flocks. This we can do with confidence only when we shall have made sure that our boys and girls receive the proper education in our primary, secondary, and agricultural schools, that will fit them for their future work on the land. In order to accomplish this, we shall require properly qualified teachers of agriculture, in addition to a thorough reformation of or revolution in our present system of primary and secondary education.

The sooner we realise the importance and absolute necessity of a suitable and thorough training for our future farmers the better. We live in an age of keen competition in nearly all branches of human activity, and also the farmer's struggle for existence cannot be maintained with success unless he is properly equipped with all that he needs. If you were to ask me, What are the most important requirements that our farmers need? I would summarise my reply in the following brief terms: a keen interest in farming, a good character, lots of common sense, self-reliance, willingness to work, and, last but not least, a thorough and suitable general and agricultural education. Given these, capital becomes of minor importance in beginning the farmer's career, and without these capital will neither last nor accumulate.

If we do not properly train our own men and women, many of them will be replaced by properly trained people coming across the seas, and our own people, thus replaced, will swell the ranks of the already dangerously large number of poor whites in our glorious South Africa, where man was not meant to want or starve. I labour this point somewhat, because I realise its awful seriousness to us of the present generation.

Co-operation is the salvation of the small farmer, but only when it is built on the two pillars of self-reliance and mutual trust. These again, and particularly the latter, are more generally found amongst properly educated men who can think for themselves and realise their position, than amongst those who can only take a personal and short-sighted view of their situation. For promoting co-operation amongst our farmers the watchword therefore again is suitable education, and enough of it.

I have already mentioned the urgent need of properly trained teachers of agriculture. These can now be trained at our Agricultural Faculties.

In conclusion I wish to offer some

Criticisms and Suggestions

with reference to the foregoing.

Our primary and secondary education must be so altered as to suit the requirements of the pupils for their battle of life. As

most of our children in the primary schools now leave school after Standard IV-VI, the school curriculum should be so arranged as to make the very best use of their short stay at school with the above object in view. Some simple talks and practical demonstrations on agricultural subjects should be introduced at an early stage in every school. It is not merely for the sake of the positive knowledge thus imparted to the pupils that I would like to see this introduced, but also because of the interest in farming it will awaken in the minds even of children who do not come from a farm. In a sheep area I would commence by giving a demonstration with a sheep, pointing out and naming the different parts of the body, telling my pupils that we eat the meat and use the wool in making our woollen blankets and clothes; further, that the wool helps to keep the body of the sheep warm when sleeping in the open just as woollen clothes help to keep our bodies warm, etc., etc. In a similar manner different animals and plants of agricultural importance can thus be prominently brought to the notice of young children, and the information given about these can be amplified and varied as the higher classes are reached. Gradually such agricultural operations as irrigation, digging, ploughing, etc., can be introduced with practical demonstrations, and this will naturally lead to talks about the different classes of soils, which will be followed by talks on the origin of these soils.

Attached to each school there should be a school garden, where pupils can cultivate individual small plots and plant seeds, etc. This work should gradually lead to the production of salad plants, potatoes, etc. The use of farmyard manure should be explained in a simple manner. The advantages of weeding and keeping the soil loose on the surface (2-3 in.) should be demonstrated by actual plots. In this way children can gain a considerable amount of most useful knowledge whilst still young, and will develop both their powers of observation and a keen interest in Nature.

In our *secondary* schools these elements should be carried a little further. *Agriculture* as a subject should then be taught, and those branches of the subject more particularly dealt with which are practised in the neighbourhood. Under this subject should be included the elements of geology, chemistry, botany, soil management, and crop production, the rearing of stock and a short description of the common breeds. Such crops and breeds should be so chosen as to represent particularly those most commonly entering the farming practice of the district or neighbouring districts. The elements of meteorology should be included in the subject of physical geography. The course in agriculture as outlined above might seem too ambitious for a secondary school to undertake. This, however, will not be the case if the teacher understands what is aimed at. Thus he should not aim at completeness, but rather select certain outstanding topics and treat these in a very clear and simple manner, going just sufficiently

into his subject to make it interesting to the pupils and to give them some useful information.

He should invariably give practical demonstrations to illustrate his instruction, using live plants and animals in preference to photographs or preserved specimens wherever possible. He should further use simple and clear language, which should be the mother tongue of his pupils, and always bear in mind the tremendous help the pupil's eye and hand can render him in teaching so eminently practical a subject as agriculture.

If the curricula of our primary and secondary schools are recast on sounder educational lines than are at present followed, sufficient time will be available to devote 3-5 hours per week to the teaching of this most useful subject.

In order best to carry out my proposals, either of the recommendations made by the "Commission on Elementary Education," appointed by the Orange Free State Provincial Authorities in 1914, and printed on pages 6 and 24 of their recently published report, should be adopted. These recommendations read as follows:—

"Further, as soon as practicable, a number of schools of a purely secondary nature should be established at various centres throughout the State, none other than such schools being allowed to do secondary work" (Majority Report, on p. 6 of the Report), and "In pursuance of what has been already stated with regard to secondary schools and the secondary divisions of primary schools, we urge that the primary and secondary departments of such schools be entirely separated, each with its own distinct staff" (Minority Report on page 24 of the Report).

If this were done, distinct courses in agriculture could be given in the primary and secondary schools respectively to suit the two classes of students concerned. As the above report has a good deal to say about the teaching of agriculture in the primary and secondary schools, I wish to recommend everyone to read it very carefully.

I shall no doubt be asked where we are to find the teachers capable of giving the above instruction. My reply to that is that we have to train them. In our training schools we have to introduce the subject of agriculture as defined above, and make it a compulsory subject for the men at least. The instruction should consist of two distinct courses according as it will be needed for teaching in a primary or in a secondary school. Once the two are separated, the correct course can be laid down as a subject in the qualifying examination.

In the cases of Pretoria and Stellenbosch I would suggest that the staffs of the new Agricultural Faculties give the necessary instruction to the students who undergo training for teachers at these centres. In case of other training centres special teachers for agriculture should be appointed or other arrangements made. In order to allow the present teachers to qualify in this subject, facilities should be granted to those who wish to take up the

study of agriculture for following the short courses or the one year course given at the agricultiural schools or the two years diploma course given at one of the agricultural schools or faculties. Special leave and bonuses should be provided to encourage teachers to qualify in agriculture. Such teachers might subsequently be given special bonuses as further encouragement. No effort and money should be spared in order to make a success of the teaching of agriculture in our primary and secondary schools, as this is a matter of vital importance to our future existence and welfare as a nation.

Before concluding this paper I wish to offer a few criticisms on the present system of agricultural education followed at our *Agricultural Schools*. Having been Principal of the Elsenburg School of Agriculture for nearly five years, I can speak on this subject with some confidence. Whilst I wish to draw attention to the fine organisation to-day existing at our agricultural schools for teaching the various agricultural subjects and carrying on a great deal of valuable investigational and experimental work, and whilst I make bold to say that the good work done at these schools is not nearly appreciated to the extent it deserves, although unmistakable and encouraging signs are noticeable in this direction, I have to admit that a considerable change of policy is necessary in order to make these schools fulfil to best advantage the functions they are intended to perform. Their great and sole object is to train future farmers and to impart agricultural knowledge to those already on the land.

The standard of admission to-day is our public school Standard VI or VII, as the case may be. Some students of course have passed their Matriculation or Senior Certificate Examination when they commence their training at these schools. The instruction given is on the whole fairly advanced, so that the Standard VII boy cannot nearly take in all that is given in the form of lectures. The Matriculation or Senior Certificate man can do so, and practically always becomes the best student. This is the weak point which needs immediate attention.

Since Agricultural Faculties have now been created at two of our University Colleges, most of the Matriculation or Senior Certificate men will prefer to take their diploma course at these faculties, and the agricultural schools will get almost exclusively Standard VII men. I might just state here, that I am of opinion that the Matriculation or Senior Certificate man, who has not already acquired some knowledge of farming, would do better by going to the agricultural school than by taking the course at the Agricultural Faculty, whereas with such knowledge he should certainly give preference to the course at the University Faculty.

To revert to the agricultural schools, I venture to suggest that the training should, if possible, be made still more practical. It certainly should be made simpler, omitting a number of somewhat advanced topics and theories, a knowledge of which is not essential to the success of the future farmer. The more elemen-

tary facts and essential points should be driven home with force and lucidity until every student has digested them.

In order to illustrate my point, I might give the following as an example. Supposing a certain plant disease is dealt with, then I would suggest that, instead of describing in detail the organism causing it and showing the student what it looks like under the microscope, etc., he should rather be told *in detail* about the species and varieties of plants liable to get the disease, the particular sites and localities as well as the weather conditions favourable and unfavourable to it, the effects it has on the plants attacked and the best times and means known for combatting it. As for identification of the disease, I would make him use his organs of sense, particularly his eyes without further aid, except in a few cases where the help of a lens might be called in.

In other words, I would train him to diagnose macroscopically and not microscopcically, as very few farmers will ever possess, much less use, a microscope. Doubtful cases could always be submitted to Government or other experts.

I do not maintain that many of the things I would like to see taught to the student are omitted at present, but by introducing too much advanced work too little time is left to drive home the more practical aspects of the question until the student has thoroughly grasped the main and essential facts.

The courses of instruction at these schools should therefore be made a little *less ambitious*, when it will be found that this seeming loss will in reality be a direct gain to the student himself. His training will be more useful and will better serve to prepare him for his future work on the farm than the present system has been capable of doing. *It is thoroughness more than completeness that should be aimed at.* The subject matter taught in the various courses should be reduced, whilst the essential matters should be expanded and made clear by constant reference to actual farming practice.

It must further be borne in mind that a Standard VII boy has no great command of language, and consequently clear and *simple* language should be used in lectures to make sure that the whole class can intelligently follow the lecturer. This becomes all the more imperative, where, as at present happens in nearly every case, half the class are taught through the medium of a language not their mother tongue. This will have to be altered soon, as a gross injustice is at present being perpetrated upon one section of the community. Had the standard of general education in this case been Matriculation and not Standard VII, matters would not have been quite so bad, although this would not yet make the present practice a just one.

As far as I can see, the remedy lies in either appointing duplicate lecturers for every subject, or thoroughly bilingual lecturers who can give their instruction through both official languages. They will then give their lectures in Dutch to that section

of the class whose mother tongue is Dutch, and in English to those whose mother tongue is English. Of these two alternatives I would give preference to the latter, if the lectures are sufficiently curtailed to make the scheme workable.

The only other solution will be that approximately half the lectures are given in one and half in the other official language. This presupposes a knowledge of both official languages as a condition of admission to the school. Once both these languages are properly and sufficiently taught in all our public schools, such an arrangement might be practicable. At the present ttime I am afraid this will not be the case unless boys whose mother tongue is English first spend a year on a Dutch farm and take pains to learn Dutch properly. Incidentally, it will acquaint them with farming and farm life, and thus serve a double purpose. Where necessary, the Dutch boy should similarly take steps to get a proper knowledge of English, although this is not the case at present generally met with in South Africa. This third and last solution of the language difficulty has much to recommend it, and is no doubt the most practical and sensible solution of the question, although I admit that from a pedadogic point of view it may be assailable. We shall no doubt before long see which solution will be adopted in South Africa.

About our higher agricultural education at the Agricultural Faculties, I shall not say much, as they are now only being started. There are four main things which I hope they will do.

Firstly, they should train men with some farming experience who have passed the Matriculation or Senior Certificate Examination to become farmers. Most of their students will at the outset probably belong to this group. After two years' study they can be awarded a Diploma in Agriculture upon satisfactorily passing the necessary tests. We shall thus get some farmers who will have enjoyed the privileges of a University education, which will enable all the better to fill their places as farmers and as members of the community, particularly as members of public bodies, such as School Boards, Divisional and Provincial Councils, and last, but not least, Parliament.

Secondly, they should provide the necessary agricultural training for our teachers as outlined above.

Thirdly, they should provide Degree Courses for the more ambitious students who wish to take their degree in agriculture, and become teachers of this subject or experts in some branch of it.

Finally, they should stimulate and actively forward research in the different branches of agriculture. In the couse of time I hope to see all these functions worthily performed by these Faculties for the welfare of the whole country, when the money now spent will return to us with more than compound interest.

(*Read, July* 4, 1917.)

AGRICULTURAL EDUCATION IN AUSTRALIA.

By CHARLES FREDERICK JURITZ, M.A., D.Sc., F.I.C.

Taking advantage of the facilities afforded by the meeting of the British Association for the Advancement of Science, appointed to be held in the chief cities of Australia during August, 1914, the writer joined the overseas party on board the s.s. *Euripides*, left Table Bay on the 20th July, and reached the first Australian port of call, Albany, on the 4th August, when the winter season in the great continent of the south was just beginning to draw to its close.

The winter in those parts of Australia where that season is usually rainy had been a dry one, but, in spite of that disadvantage, there was, to South African eyes, a freshness and verdure about the country's meadow-lands that seemed to tell of a more lavish distribution of Nature's bounties than South Africa's veld as a rule experiences; indeed, the park-like appearance of the fields round about Angaston (South Australia) made it difficult for some members of the party to realise that they were 12,000 miles distant from Surrey.

The annual meetings of the British Association are usually characterised by excursions to various places of scientific interest. Especially is such the case when those meetings are held in one or other of the overseas Dominions of the British Empire. In Australia almost every branch of science offered for inspection features novel to the great majority of the visitors, and so there were primary excursions to the great mining centres, as well as to places of interest, variously, to geologists, botanists, anthropologists, etc.

Wherever it was possible to do so, the writer selected an excursion agricultural in its bearings, opining that thereby a greater benefit might be conveyed to South Africa than by the mere inspection of some of the striking natural beauties of Australia, or by becoming personally acquainted with that country's mining industries. Such an inspection or acquaintance would after all prove of little more than personal interest, while in agricultural matters South Africa is not so far advanced as to be beyond the possibility of learning a great deal from the sister Dominion of the South, much to her own benefit.

It therefore became practicable for me to visit some of the institutions in Australia where agricultural education is carried on and to inspect, amongst others, at least one experiment station where a series of investigations is in operation that are of no less vital interest to South Africa than a proper system of imparting both theoretical and practical knowledge of agriculture. With that particular station and its functions—I refer to the prickly pear investigational work at Dulacca—I have specially dealt with elsewhere.*

* C. F. Juritz: "The Prickly Pear Problem in Australia" (1915). pp. 14.

Western Australia.

My stay in Western Australia was much too short to permit of any personal insight into that State's system of agricultural education, but I know that a chair of Agriculture has been provided in the University of Western Australia, by the generosity of the Chancellor, Sir Winthrop Hackett, and this to some extent compensates for the fact that Western Australia differs from the other Australian States in not possessing an Agricultural College. I also gathered that, at the larger centres, boys in the primary schools receive instruction in manual training, and girls in cookery and domestic economy, and that, wherever possible, the practice of agriculture is inculcated by means of school gardens. The schools of Western Australia do not confine themselves to the ordinary curriculum, but make a point of imparting knowledge of such subjects as carpentry, horticulture, and others which tend to fit the children to become useful settlers on the land.

South Australia.

Roseworthy College.

In South Australia, the University of Adelaide, in conjunction with the Government Agricultural College, makes provision for a course whereby students are enabled to obtain the degree of B.Sc. in Agriculture. Part of this course is taken at the University, and part at the Agricultural College. This college, situated at Roseworthy, is affiliated to the University, and thus affords to students an alternative to the Technical School at Perth, Western Australia, which is likewise affiliated to the South Australian University of Adelaide. The teaching at Roseworthy in agriculture, viticulture, etc., is accepted as part of the University course for B.Sc. in Agriculture; and so, too, the teaching at Perth in chemistry, physics, mathematics, etc., is accepted as part of the Adelaide University course for the ordinary B.Sc. degree. By co-operation of the University and the Forest Department, arrangements exist for the successful training of foresters. The Forest Department issues a prospectus of courses of training, and it is possible to obtain the university degree of B.Sc. in the subject of Forestry.

It was my privilege thoroughly to inspect not only the actual University buildings at Adelaide, with their equipment, but also those of the Government Agricultural College at Roseworthy. The Roseworthy College, which was founded in 1883 for the twofold purpose of training young men in the practice of agriculture, horticulture and viticulture, and of conducting experiments with a view to the advancement of rural industries in South Australia, is situated on a wide level plain, thirty miles north of Adelaide, and about eight miles from Gawler, a small South Australian engineering town. The college lands extend over some 2,000 acres. The writer visited this institution in company with about 20 other members of the British

Association, including Dr. A. Lauder, of the Edinburgh and East of Scotland College of Agriculture, and Mr. J. Golding. F.I.C., of University College, Reading, Recorder of the Agricultural Section of the British Association.

The road to the college traverses extensive cultivated grain lands, which had in their original condition presented that resemblance to a park that I have already referred to. The lands were scattered over with trees, such as the Mallee Box (*Eucalyptus longifolia*) and a species of Callitris or native pine. The former is used largely as firewood, and it is said that there is no other tree better fitted to serve that object. The poorer lands are thickly covered with a weed known as "stinkwort," while the Mallee Box flourishes on limestone areas, and the Callitris principally on the sandhills.

It is interesting to note that a larger number of old Roseworthians occupy professional positions in other Australian States than alumni of any other Australian institution. Many others who have received their agricultural training at Roseworthy are now amongst the most prosperous farmers in South Australia. The present principal of Roseworthy College, who had only just taken up his charge there, is Mr. W. J. Colebatch, B.Sc., M.R.C.V.S., late manager of Kybybolite Experimental Farm, and Superintendent of Agriculture in the south-east of the State. Mr. Colebatch is himself an old pupil of Roseworthy, and was its gold medallist in 1898, and, according to the Hon. T. Pascoe, M.L.C., Minister of Agriculture, his appointment marks the first occasion in the history of Australia on which a former student of a college has risen to be its principal.

The former principal of Roseworthy was Mr. A. J. Perkins, who was appointed a lecturer there in 1893, became principal in 1904, and had just been promoted to the post of Director of Agriculture for the State of South Australia, in place of Mr. W. Lowrie, M.A., B.Sc.

In the Commonwealth, unlike South Africa, each State has its own Agricultural Department; and, when discussing the merits of the respective systems, one detected, now and again, latent fears that substitution of one Commonwealth Department for those of the different States might not prove an unalloyed advantage for those States which possess the most efficient departments under their present system.

Both Mr. Perkins and Mr. Colebatch spontaneously and emphatically expressed the view that the system of instruction adopted at Roseworthy is not a system artificially imposed on the country, but one that has been developed along the lines of the country's manifested needs. Sounder views there cannot be.

In some countries, systems of short courses are favoured in connection with institutions whose aim is to provide agricultural education. Of at least one type of short course the South Australian Director of Agriculture expressed unqualified disapproval. The staff, he said, has no time for anything except the legitimate work of the College, namely, to fit the students to take

up farming operations. Now farmers sometimes expect their sons, after completing their agricultural college course, to be thoroughly proficient, for example, in all the blacksmith work required on their farms. All such ideas Mr. Perkins strongly discourages at every opportunity, holding, as he does, that the students should not endeavour to become in any sense specialists, but that they should receive just the instruction which they need —and a little beyond—in each actual branch of science or art, for the main purpose for which the College exists.

In discussing the subject of practical field work, Mr. Colebatch expressed the opinion that the cultivated land of an agricultural college should never be less than 20 acres per student instructed; so that 1,000 acres—the area now under actual cultivation at Roseworthy—should just suffice for its 50 students, if all are to do sufficient manual labour to give them all-round practical experience. A strong point is made of the students becoming practically acquainted with all branches of manual labour required on the farm.

The curriculum at Roseworthy Agricultural College is as follows:—

First year: Agriculture, Chemistry, Book-keeping, Veterinary anatomy, Physics, Botany, Mathematics, and English.

Second year: Agriculture, Viticulture, Fruit culture, Chemistry, Surveying, Dairying, Veterinary physiology, Physics, and Wool-classing.

Third year: Agriculture, Viticulture, Fruit culture, Chemistry, Surveying, Dairying, Veterinary science, Aviculture, and Wool-classing.

Entomology and zoology, it will be seen, do not enter into the curriculum.

The fees are £30 per annum, and arrangements may be made for special six months' courses in dairying and aviculture. Particular attention is devoted to "diversified farming"; and, in addition, valuable experiments are carried on in livestock breeding, poultry and dairy farming.

Of all the lands connected with Roseworthy College, about 50 acres are under vines, but by far the greater area is devoted to cereal cultivation—and not unnaturally, for 92 per cent. of the cultivated land in the surrounding districts is under cereals. In the Roseworthy district 20 bushels of wheat per acre, or two and a quarter tons of hay, represent average yields, but it is held that, with 15 inches of rain well distributed over the growing period (April to November), 30 bushels of wheat, or three and a quarter tons of hay, are possible. On the College wheat-lands, where cultivation has been carried on for the last 50 years, the soil, in common with all lands in the vicinity, lacks phosphates.

This year, for the first time, the crops were found to be affected with a white rust or mildew (thought to be *Erysiphe graminis*). The exact nature of this mildew had not been ascer-

tained, we were told, because the State had only one mycologist, and he is stationed at Adelaide. At the time of our visit experiments for the extirpation of this pest were being tried with sulphur, Bordeaux-mixture, etc.

The wheat-lands receive superphosphate at the rate of 80 lb. per acre, *i.e.*, only sufficient for the immediate season. These lands are in part surrounded by eucalyptus, and the stunting effects of the trees on the wheat-fields was strikingly manifest wherever they grew in close proximity to the cereals. Millets, it is said, do not thrive on the farm lands.

Considerable interest was manifested by the visiting party in the newly-erected shed containing appliances for grading wheat, the whole series being driven by a small petrol engine. These appliances include a hand thrasher for small quantities of grain, capable of taking about one-third of a sheaf.

The rotation frequently adopted in the district is said to be: (1) Self-sown grass herbage, (2) bare fallow—the land being kept broken by cultivators—and (3) wheat. This system, however, is regarded, not without evident reason, as not getting enough out of the land.

The Roseworthy rainfall averages seventeen inches, and the lands are irrigated from the Barossa, sixteen miles away, the whole district being reticulated with water-leadings. The only method of irrigation used all over the farm is that of revolving sprinklers. Flood irrigation is impracticable on account of the expense, which would render it unprofitable. The cost of water is sixpence per 1,000 gallons, exclusive of water-rates. The sprinkling system, however, is found to yield good returns. As an instance of this we were informed that a herd of 25 cows was entirely maintained on four acres of Egyptian clover from July to October, both months inclusive, the clover being cut five times per annum, with constant irrigation, except during the wet winters, when irrigation is used only to start the crops. Brack efflorescences occur on the farm, chiefly in the form of magnesium chloride, until irrigation drives the salts down.

Nitrogen manuring (Chili saltpetre, etc.) is stated to have failed in yielding sufficient crop-increase to make such manuring profitable. It was not on the occasion of my visit to Roseworthy that I heard this statement for the first time in South Australia. On the contrary, it was frequently reiterated in my hearing, both before and after that visit, not only in that State, but also in other parts of the Australian continent; indeed, the South Australian Government's "Handbook of South Australia," issued in 1908, states (page 270) that—

> In addition to the absence of excessive rains, South Australian farmers have a great advantage over their European competitors in that the addition of nitrogenous manures is unnecessary for cereal growing. *The soil is self-nitrogenating.** The nitrogen-producing bacteria thrive wonderfully in the warmer and drier conditions of this State.

* Italics in the original.

Mr. A. D. Hall, in the course of his address at Brisbane, on the 28th August, on the subject of "Tropical Agriculture," observed that he, too, had heard this remarkable assertion, but had not come across sufficient evidence in support of it.

On the Roseworthy lands, as well as throughout South Australia, phosphatic manures are generally employed. Superphosphates, more largely made locally than imported, are prepared from phosphate rock brought from Christmas Island, and may be procured at a cost below £4 per ton. It is said that the quantities of superphosphate which find most favour vary from 40 lb. to 1 cwt. per acre.

I was not able to gain much information regarding the physical or chemical composition of the soils, either at Roseworthy, or elsewhere in South Australia, but the few soil analyses that I had the opportunity of studying there showed healthy proportions of potash and lime, though their phosphate-content was open to improvement. No geological or agricultural survey of South Australian soils has yet been undertaken. The value of land, we were informed, was, in spite of bad seasons, £9 10s. per acre in the vicinity of Roseworthy, and near Roseworthy Railway Station has realized about £11.

The farm pedigree stock at Roseworthy comprises horses and horned cattle, as well as Southdown and Merino sheep. The horned cattle number 45, being all Australian-bred Jerseys. 16 of these were in milk at the time of our visit, and the fat-content of the milk averages from 4½ to 5 per cent. Cheese is not made at the institution.

Roseworthy does not stock Dutch cattle, nor, in fact, have there been large importations of cattle from Holland into any portion of South Australia, the most famous breeds of horned stock in the State being the Angas stud of Shorthorns and Herefords, bred from the late Mr. J. H. Angas's imports many years ago, and the "Mount Crawford" herd, bred from purchases made in Jersey by Mr. A. J. Murray.

Roseworthy College maintains a small yard of poultry (White Leghorns), but solely for the institution's private use.

Farmers' Bureaux.

Mr. Perkins' disapproval of the short-course system has already been remarked upon, but that is far from indicating any disposition to withhold from the man who has actually taken up the vocation of a farmer all possible means of adding to his stock of knowledge. On the contrary, the Department, by means of its Bureau system, does all in its power to aid the farmer.

This Bureau system was inaugurated in South Australia 25 years ago, but has been under thorough organization only during the last three years. The Agricultural Bureau of South Australia now numbers 4,000 members, and possesses 135 branches; while its operations have brought about a feeling, not only of mutual confidence but also of friendship, between the farmers individually and collectively, and the Department of

Agriculture. New South Wales is endeavouring to organise its farmers along similar lines, while Queensland and Western Australia were making inquiries with a view to initiating organisations of like character.

Under this Bureau system, the farmers of the State are grouped into a number of separate "Branches," each of which meets monthly for comparing notes, reading papers, and discussion. The papers, together with the Secretary's notes of the discussion, are subsequently edited, and published in the State's *Journal of Agriculture.* The Branches also conduct field experiments for the Department, and maintain demonstration-plots on their own account. Each branch has its own honorary secretary, and all the Branches are under the general control of a Board, which is also the general Advisory Board to the Department of Agriculture.

At the monthly meetings of the Branches, the scientific and technical experts of the Department attend, and lecture if required; but in some Branches it has become unnecessary to depend upon the departmental experts for lectures, for in those localities all the lectures have for some years been delivered by the farmers themselves. These lectures, too, are afterwards edited, and published, together with the reports of the proceedings of the Branch, in the *Journal of Agriculture of South Australia.*

The July, 1914, issue of that Journal contains the summarized reports of meetings independently held by no less than 75 different Branches; in the September issue 94 meetings were similarly reported, and in the October issue 57. And these, it must be remembered, differ widely from South African Agricultural Congresses, in that they are far from being primarily business meetings, but in almost every case there were lectures, papers, or discussions on different phases of farm practice.

It is the publication of reports like these that renders the South Australian *Journal of Agriculture* readable to farmers. which it would not be if the Journal consisted of the more technical matter which is, under the system in vogue there, assigned to the South Australian Agricultural Year-Book.

In connection with the Bureau meetings, what is called the "Question-box system" may be mentioned. There are many points on which go-ahead farmers are constantly desiring explanations: all they have to do is to write their inquiries on slips of paper and drop them in the Branch's question-box. At the meeting, the papers are opened and the questions discussed, those who have experience on the particular point communicating their views for the benefit of those who lack. If the question happens to be one which only one of the Department's experts can answer, it is forwarded for that purpose to the Department of Agriculture, and if, at any time, a farmer belonging to one or other of the Branches desires to avail himself of the services of such an expert—who, by the way, would not be stationed at Roseworthy, but in the offices of the Department at Adelaide

—all he has to do is to put his inquiries through the medium of the question-box, or to communicate with the Secretary of his Branch, who then passes the request on to the Secretary of the Associated Board. The latter, a permanent official of the Agricultural Department, thereupon communicates the desire to that particular sub-department whose proper function it is to deal with it.

In addition to their monthly meetings, above referred to, all the Branches in the State meet unitedly in Congress once every year, and on such occasions the Government presents two delegates from each Branch with free railway tickets. Moreover, when agricultural shows take place at Roseworthy, farmers are given not only free railway return tickets, but are in addition provided gratis with a luncheon at Roseworthy, and a drive of inspection round the farm.

"Homestead meetings" constitute an important feature of some Branches. Members journey to the homestead of one of their number by invitation, and there inspect crops, livestock, and machinery; business is also transacted, and a social hour is spent. The mutual value of such excursions to host and visitors need not be further emphasised to those who have attended our Dry-farming or Irrigation Congresses. Some Branches arrange field-trials of implements, from time to time, when the assembled farmers have opportunities of judging the merits of various makes and patterns.

Another development of the homestead meetings is the institution of competitions: for instance, there was a pruning competition at Clare in June, 1914, under the auspices of the Clare Branch of the Agricultural Bureau. There were eight classes, viz., apricots, apples, peaches, currants, sultanas and wine-grapes, as well as two for youths under 15. This has since further developed into a gold medal championship competition which is to last over three years, the respective competitors handling the same tree year after year.

Finally, experiments in manuring, cultivation methods, crop-rotation, etc., are carried out by members of the Bureau, on a properly organized plan, on behalf of the Department, which keeps careful records of all that is accomplished and publishes the results. There is, in fact, a special Experimental and Demonstration Plots Committee of the Agricultural Bureau of South Australia whose particular function is to organise these tests in the field.

South Australian Experimental Farms.

An important function in South Australia's system of agricultural education is vested in the experimental farms. As in the United States of America, these farms may or may not be connected with the establishments for agricultural education; but it is of value to remember that there is a definite distinction between the agricultural colleges and the experiment stations.

An indication was given above of the manner in which co-

operation between the farming community and the Agricultural Department has been established in South Australia, but this co-operation may be said to be double-headed: not only does the Bureau system facilitate the spontaneous performance of plot-experiments by the farmers for the Department, but conversely the system of experimental farms enables farmers to see analogous plot-experiments conducted for them by the Department.

The experimental farms carry out two classes of work, namely: 1. Demonstration work on private farms, that is to say, operations the results of which can be predicted beforehand by the departmental experts, but are intended to be of the nature of direct instruction to the farmers; and (2) experimental work on State farms, the results of which cannot be foreseen, even by the technical officers of the Department. The results of this latter class of work may be shortly described as Nature's answers to the questions put to her by the investigator, while in the former class the worker aims at passing on to the farmer the answers which either he, or other investigators before him, had previously elicited from Nature by their experiments.

South Australia being so largely a cereal-growing State, the work of the experimental farms conforms closely to the exigencies of grain-culture. Hitherto this work has embraced six sections, namely: (1) Wheat variety tests, (2) complete *vs.* incomplete manurial tests,, (3) hay tests, (4) feeding-off experiments, (5) potato experiments, and (6) fodder crops.

In addition to the experimental farm directly connected with Roseworthy College, there is a farm of 2,300 acres at Kybybolite, on the Victorian border, where the Superintendent of Agriculture for the south-eastern part of the State has his headquarters, and where general experiments dealing with the special agricultural conditions of that district are conducted. Turretfield is primarily a seed-wheat station of 1,600 acres, but 30 acres of alluvial land are devoted to irrigation problems on the Para River. South of the Murray River, where the rainfall averages only 10 to 12 inches per annum, there is an experimental farm of 4,600 acres at Veitch's Well, and at Booborowie is another seed-wheat station, specially designed to serve the northern districts, and utilised at the same time as a training farm on which town boys, in particular, may be converted into efficient farm-hands, and, if they manifest sufficient thrift, are directed into the way of ultimately farming blocks of land on their own account.

Victoria.

Werribee Central Research Farm.

In the State of Victoria, a large party visited the Werribee Experimental Farm, adjacent to the railway line near Werribee Station. This Central Research Farm, as it is officially styled, was acquired by the Department of Agriculture of Victoria from the Closer Settlement Board in July, 1912, and is only 18 miles from Melbourne, the farmstead itself being about one mile from

Werribee railway station. The farm possesses comparatively good lands, as well as definitely poor soil. Of the 1,167 acres, which constitute the farm lands, about 837 are poor or fair clays or stony loams; the remainder is fair to good red volcanic loam overlying clay. Of the latter 2,000 acres are irrigable.

On arrival at the farm gates, a halt was made, and all gathered round one of the large drags which had conveyed us thither, and from which a few words of welcome to the State of Victoria, and particularly to Werribee Central Research farm, were then addressed to us by the State Minister of Agriculture, Mr. W. J. Hutchinson, who had accompanied the party from Melbourne. The Director of the Research Station explained the purpose of the wheat investigations which constitute the principal work of the Station. At present, he said, the varieties of wheat cultivated in Australia are not sufficiently drought-resistant, and so endeavours are being made to obtain drought-resistant wheats, by importing these, not from humid climates, like Europe, whence the wheat cultivated in Australia was originally imported, but from the driest possible countries; and then it is sought either to acclimatize the wheat so imported, or by cross-breeding, to set about procuring grain suited to the country's special conditions.

In addition to research work and investigation experiments, the Werribee farm undertakes practical demonstrations in agriculture and livestock husbandry. Of the investigations the chief heads are:—

(*a*) Improvement of wheat and other cereals, grasses, and economic plants, by selection, stud-breeding, and hybridising;
(*b*) Soil renovation, fertilising, and tillage methods;
(*c*) Rotation of crops, and improved cropping practices;
(*d*) Irrigation practices, drainage and aeration of soils;
(*e*) Improvement of natural pastures, and trials of artificial grassing with exotic and native grasses;
(*f*) The breeding and feeding of livestock, improvement of milk-yields, and production of standard export types of lambs;
(*g*) Research concerning soil-moisture, temperature, biological conditions, and nitrification processes, and the nutrition of plants;
(*h*) Meteorological observations relating to agriculture.

Broadly speaking, all these investigations may be grouped under the three heads of dry-farming investigations, irrigation investigations and livestock investigations.

The dry-farming experimental work is carried on in nine sections. These are: (1) Permanent rotation tests, (2) cereal experiment fields, (3) grass seeding trials, (4) top-dressing of natural pastures, (5) legumes for soil-renovation, (6) top-dressing of cereals with nitrates, (7) pot experiments, (8) modes and depths of ploughing, (9) bulk wheats for seed.

It is impossible to refer to these experiments with anything like detail in a paper such as this, but it may suffice to say that, as the farm was so recently acquired, much pioneering work had to be done in each case in order to get the various experimental plots set going. For instance, the permanent rotation tests comprise ten different systems of rotation, and these again are divided amongst 26 half-acre plots, but in every one of these the earliest sowing took place during the 1913 season, so that obviously there had been no time for any results.

The bulk of the farm lands, as already indicated, is poor; oats have been grown on the land for nearly 30 years without a rest, and the lands are evidently worn out. The soil is floury after dry cultivation, sets hard on drying after rain, and is plainly deficient in humus. Two methods of supplying this deficiency in the quickest possible manner are being investigated: these are the feeding off and the ploughing in of green-crops.

The irrigation experiments are carried on in two sections, one being devoted to forage-crops and grasses, and the other to lucerne fields. The latter is sub-divided into five sub-sections having reference respectively to the efficacy of various top-dressings on established lucerne, soil liming and inoculation trials, fertiliser trials, lucerne variety and seeding tests, etc.

In this connection it was of interest to learn that a 15-acre plot, sown with lucerne two years ago, and flood-irrigated from a wide concrete canal, yielded a crop of six and a half tons of lucerne per acre over its entire area, and sufficed to feed 850 sheep for eight days. The irrigation-canal leads by gravitation from an elevated circular tank of reinforced concrete, to which the water is pumped up from the Werribee River, about a quarter of a mile away.

The meteorological observations taken at Werribee comprise records of rainfall, loss by evaporation, sunshine records, earth temperature, etc. The temperature of the soil during the summer months averages 90 deg. F., and to this fact was ascribed the nitrogen activity of the soil, and the common experience, here, as in South Australia, that the artificial supply of nitrogen is unnecessary. The annual rainfall of the station averages 19.5 inches, and a thoroughly representative sample of every fall of rain is collected and regularly analysed.

While the farm livestock was being inspected by the visiting party, Dr. S. S. Cameron, Chief Veterinary Officer of the Victorian Department of Agriculture, said that 12 head of red hornless cattle had recently been imported, and that only one of these had since been found to average less than 600 gallons of milk per annum. Endeavours are being made to establish a breed of cows which will be not only hornless, but also good milkers and good meat-producers; and the Red-Poll cattle that constitute the dairy herd on the farm have proved in every case to put on flesh rapidly as soon as the lactation period comes to an end.

The Werribee Red-Poll herd now consists of 22 cows and

six heifers, and from these the following averages have been obtained:—

	Days in milk.	*Gallons of milk yielded.*	*Fat percentage.*	*Estimated yield of butter.*
22 Cows	283	657	4.52	337 lb.
6 Heifers	302	428	4.48	218 lb.

In connection with the breeding of sheep, investigations are in progress, by mating cross-bred Riverina ewes, of uniform type and quality, with Lincoln, Border-Leicester, English-Leicester, Shropshire, Southdown, and Dorset-Horn rams, to discover the most suitable type of ram for the breeding of export lambs.

The horses working on the farm are all Clydesdales. There are no special stud-mares, but a Clydesdale stallion has recently been procured.

At the conclusion of a most interesting and instructive day, Mr. A. D. Hall, M.A., F.R.S., formerly Director of the world-renowned station at Rothamsted, proposed a vote of thanks on behalf of the visitors. In the course of his remarks he alluded to the fact that he had been connected with the oldest experiment station in the world, founded over 70 years ago; and when he saw this beautifully laid-out station of Werribee, established only two years ago, he began to realize how rapidly things move in Australia. The work that had been begun at Rothamsted more than 70 years ago was only now yielding its results, and some time must necessarily elapse ere the results of the work which had been so well planned, and is being so well carried out at Werribee, could appear. He therefore counselled patience, especially as he considered that at least five years should be devoted to any individual experiment in order to secure a satisfactory test.

Other Victorian Experimental Farms.

In addition to Werribee, ,the State of Victoria possesses three other agricultural experimental farms of similar type, viz., at Rutherglen, Wyuna, and Bamawm. Rutherglen Viticultural College, as its official designation implies, is charged in addition with experimental work connected with viticulture, and, in particular, with the raising of phylloxera-resistant vines. Wyuna is an irrigation farm of 22,500 acres, one half of which is timbered with box and occasional Murray pines.

Werribee and the other three farms just named, it must be understood, are not agricultural colleges like Roseworthy in South Australia; their object is not the direct training of intending farmers, nor is it that of attaining financially profitable results by their farming operations; their whole function is that of conferring on the agricultural industry of Victoria the benefits of modern scientific advances, by the prosecution of investigations and trials, under practical and accurately-recorded conditions. In other words, the State of Victoria, like South Aus-

tralia, clearly recognizes the difference between an experiment station and an agricultural school or college.

But in Victoria, as in South Australia, and as in the United States of America, one may also find both the distinct functions performed at one institution. Such an institution is the Agricultural College and Experimental Farm at Dookie. It is much larger than Roseworthy, extending over some 6,000 acres, and accommodates 80 students. At Longerenong, near Horsham, there is another college and farm, accommodating 40 students. At Melbourne University there is a School of Agriculture, presided over by a professor of agriculture, but not furnished with an experimental farm. Moreover, the Education Department of Victoria has established a number of agricultural high schools, or, as they are described, "secondary schools with an agricutural bias"; and every primary school in the State has its special garden and experimental plot, as it is called. These plots are, of course, not strictly "experimental"; they are demonstrational. Experimental they may be only from the child's view-point, that is, they are intended to demonstrate to him, by his own personal experience, agricultural facts already well-known to science; they are in no sense of the word of an investigational or research character. One cannot, in view of the confusion often apparent in the mind of the general dealer, emphasise these distinctions sufficiently strongly.

Agricultural Training in Victoria.

The full scheme of agricultural education in the State of Victoria comprises the following activities:—

1. Agriculture at the State schools.
2. Agricultural high schools.
3. Lectures and demonstrations to farmers.
4. Farmers' classes.
5. Agricultural colleges.
6. Demonstration and experimental farms.
7. University course in agriculture.
8. Livestock Institute and veterinary course.

The necessary equipment to carry out this scheme is provided by means of four classes of institutions: —

(*a*) Primary schools and agricultural high schools, controlled by the Education Department.

(*b*) The Dookie and Longerenong Colleges, controlled by a "Council of Agricultural Education."*

(*c*) The Werribee Experimental Farm, controlled by the Department of Agriculture.

(*d*) The Agricultural School of Melbourne University.

In addition there is the Department of Irrigation, with its own special functions and activities.

* In all the Australian States, Victoria alone excepted, the agricultural colleges are under the direct control of the respective Departments of Agriculture.

What everyone interested in the future of South African agriculture should realise in this connection, is that in Victoria no effort is spared to enlist the child's ideas and inclinations on behalf of agricultural pursuits, from the very earliest age possible.

The Victorian Department of Education controls 2,000 primary schools, with their plots and gardens. Of these schools, 700 have regular courses in agriculture and Nature-study, and before leaving the primary school, the pupil is taught the significance of schoolroom and plot experiments of an elementary character, with plants and crops.

Next comes the agricultural high school. Ten schools of this type are dotted about the State of Victoria, and each one has its own laboratories and a farm varying in extent from 20 to 85 acres. At these schools, one-third of the students' time is given to agricultural and other science, inclusive of agricultural chemistry, botany, zoology, farm carpentry, etc., and one-third to practical farm-work. The object of these farms, let me remark here too, is purely demonstrative.

From the agricultural high school the student passes to one of the colleges whose establishment was authorized under the Victorian Act of 1884. The two colleges already named have been instituted in order to produce young farmers efficient in every branch of agricultural industry. For this, Dookie prescribes a three-year and Longerenong a two-year course. The colleges also carry on experiments in wheat-breeding, fodder-growing, and in connection with horticulture, viticulture, and livestock.

Of higher grade than Dookie and Longerenong Colleges is the University School of Agriculture. Here a four-years' course of lectures, laboratory and field work leads up to the degree of B.Sc. A shorter course of three years may be taken, on the satisfactory conclusion of which the University grants the student a diploma of agriculture.

The whole of this series of ascending grades of agricultural education is under the ultimate control of the Victorian Department of Public Education; but instruction of a more directly practical character is arranged by the Department of Agriculture for those who are already engaged in farming.

This purpose is served by what are called Agricultural and Pastoral Societies, more or less analogous in their nature and functions to the Branches of the Agricultural Bureau of South Australia. There are over one hundred of these societies in Victoria. The Department of Agriculture arranges classes and courses of lantern-lectures for any society that may express a desire for these, and that guarantees a minimum attendance of 30 at the classes, or of 15 at the lantern-courses. In addition, the Department gives a bonus of £10 to each Society that constitutes a class, and £5 to each one arranging a lantern-course, in order to stimulate societies to efforts of this kind.

A school of horticulture is carried on by the Department at

Burnley, three miles from Melbourne, where tuition may be obtained in fruit drying and preserving, and other branches of horticulture, as well as in the less cognate subjects of apiculture and poultry farming.

In the Heytesbury Forest large areas of grass-tree country occur, and an experimental farm of 1,200 acres was established there in 1906, for experiments in reclamation, with a view to closer settlement. In Ballarat East, a small farm of 110 acres was established at Mount Xavier, under the supervision of the Principal of Ballarat District Orphanage, which adjoins the farm.

In order to provide suitable teachers to take agricultural subjects in the primary and secondary schools, courses of lectures on practical agriculture, accompanied by weekly demonstrations of agricultural principles, are given at the Teachers' Training College. For farmers, agricultural lectures and demonstrations are held in all parts of the State; and the farmers' classes previously referred to generally last a fortnight, and consist of lectures, field demonstrations, and lantern discourses.

The chemical, botanical, entomological, and other branches of the Agricultural Department have their headquarters at Melbourne, and the officers in charge of each are advisory towards farmers collectively and as individuals, and at the same time carry on research and investigation connected with their particular branches, administering also such statutes as the Artificial Manures Act (of which the chemist is in charge), the Vegetation Diseases Acts, etc.

Incidentally it was of interest to notice that the chemical laboratories of the Agricultural Department also carry on the work required under the Excise Tariff Act, the Wine Adulteration Act, the Pure Foods Act, the Amended Poisons Act, and the Commerce Act.

New South Wales.

Its Model Educational System.

New South Wales has been indicated as the one State of the Commonwealth which surmounts all the others in the extent, the complexity, and the ambition of its educational system. It is in New South Wales also that agricultural education forms, along with the trades school, the domestic school, and the commercial school, a definite and integral part of the general system of public education, a system beginning with the kindergarten, and leading up continuously to the University. More than that, Prof. Francis Anderson, of Sydney University, expects* that the ideas and correlated system of the New South Wales scheme will in time prevail throughout the Commonwealth.

A brief outline of the general scheme of education in the

*"Educational Policy and Development"; in the Federal Handbook of the Commonwealth of Australia (1914), 528.

State of New South Wales will serve to show just where agricultural education fits into the scheme.

In New South Wales, then, the educational system commences with a two-years course in the kindergarten. This is followed by a six-years primary school course, at the end of which, prior to admission to higher courses, a qualifying certificate is required in proof of completion of the full primary course. For further instruction the young student may choose, broadly, between three two-year courses, namely, (1) the evening continuation school, (2) the superior public school, and (3) the first two-years course of the High School. Of these three, each of the first two again offers three choices; these are, in both classes (*i.e.*, in evening continuation as well as in superior public schools), (*a*) junior technical schools, (*b*) commercial schools, and (*c*) domestic schools for girls. For the high-school course above referred to there is a choice between (*a*) the district school, (*b*) the intermediate high school, and (*c*) the high school.

Each of the three sets of two-year courses finishes up with a certificate following on naturally from the particular course taken; the student may thus acquire either a continuation school certificate, or a superior public school certificate or an intermediate certificate.

Further vistas now open before him. If he has a continuation school certificate, he may choose between entering the central technical college (which is the channel of entrance either to the trades school or the advanced domestic school, or the advanced evening school: if he has the intermediate certificate, two alternatives are likewise open, he may either continue in the high school for the third and fourth-year courses, or—and this is where agricultural training finds its niche—he may proceed to Hawkesbury Agricultural College.

After completing either the high school course or the four-years' agricultural course at Hawkesbury, the student receives a leaving certificate, and may then either proceed direct to Sydney University, or, if he wishes, first pass through a teachers' college or the advanced courses at the technical college, and thence a way is opened by which he, too, may ultimately enter the University.

It remains to be added that the principle of free education prevails throughout the greater part of the above scheme, fees being charged only in the highest grades, while liberal provision is made for bursaries and scholarships.

Hawkesbury College.

In New South Wales, as in Victoria, a chair of Agriculture has been established at the University, to which Hawkesbury Agricultural College has been affiliated. Sydney University has, moreover, a chair of Veterinary Science, and so, although difficulties have been experienced in the past in obtaining men for investigational work in connection with the 15 experiment and demonstration farms under the Agricultural Department's con-

trol in various parts of New South Wales, the University instruction now definitely established is expected to lessen the difficulties in the future.

Hawkesbury College is 38 miles from Sydney, and affords intending farmers a three-years course in the science and practice of agriculture, leading up to a diploma.

Here, too, the authorities of the Department and the staff of the College expressly disclaim any idea of turning out experts. They consider the latter to be the function of the University. It was quite amusing to notice how, almost at the outset of each visit, this disclaimer was made by one or other member of the staff of every institution visited in the different States. At Hawkesbury, in the unavoidable absence of the principal, the very large party of visitors was welcomed by Mr. Cuthbert Potts, B.A., Lecturer in Chemistry and Physics, and in his address of welcome Mr. Potts made it plain that the College did not concern itself in the training of scientists, but aimed at training practical farmers. The institution trains students for the management of mixed farms, irrigation farms, dairy, wheat, piggery, and poultry farms, orchards and vineyards. There is another section of the College which prepares students for posts as dairy-factory managers, butter-makers, cheesemakers, milk-testers, and inspectors.

The student may get his three-years course at Hawkesbury, and then go for a specialized purpose either to Wagga-Wagga or Bathurst, institutions to which reference will be made later on. Hawkesbury College, where the teaching is in general more advanced than at those two institutions, can accommodate 200 students. The main building is quadrangular in plan, lighted throughout electrically. In the students' quarters—a two-storied brick building—each student has a separate room. I noticed that many of the walls of the Hawkesbury main and out-buildings are covered with a creeping *ficus* (*F. repens*). It needs pruning twice or thrice in the course of a year, but compensates for this trouble by yielding a good supply of edible figs.

Of Hawkesbury's three-year course the first year is devoted to elementary instruction, and the last two years to practical agriculture. Throughout this whole course the instruction given is general in its character. There is also a separate two-years dairy course*, and students may take both the general and the dairy course within a period of four years. Hawkesbury furthermore provides short courses for older men who wish to specialise.

There were 185 students in residence at the College just before the war, but by the time our visit took place many had volunteered for active service and left.

The daily round of instruction at Hawkesbury commences at exactly the same hours as if the students were already engaged in their profession of farming, *i.e.*, those occupied in field-

* The full official title of the institution is "Hawkesbury Agricultural College, Dairy School, and Experiment Farm."

work begin at 7 a.m., and the students doing dairy work commence in two batches, the earlier at 4.30 a.m., and the later at 5.30. The lectures start at 8.30.

Amongst the subjects taught are carpentry, wheelwright's work, saddlery, butchery, engineering, blacksmithing, jam-making, etc. We inspected a number of excellently-made metal implements, turned out by the students, of such a miscellaneous nature as horseshoes, chisels, plough-stays, punches, steel spanners, gate-hooks and hinges, cultivator tines, etc. Complete set of harness are also made, including both the metal and the leather work.

A visit was paid to the poultry runs, where we noticed a very large number of egg-laying competition pens. In the competitions outsiders participate. Of course, the institution has, in addition, its own stock of poultry, and pure-bred varieties of table and laying fowls, ducks, turkeys, and geese are to be seen. There are, moreover, about one dozen ostriches on the farm, the sight of which reminded me of a remark made by an Australian gentleman during the course of an excellently illustrated lantern-lecture on "Australia and its industries," delivered by him on board the *Euripides* on the outward voyage. South Africa, he said, guarded her ostriches very carefully, and strictly prohibited their export; but there were means of circumventing those prohibitions, and in proof hereof a fine slide of Australian-bred ostriches was shown. These birds, it was hinted, might have been exported from Africa through ports other than those of the Union.

Connected with the Hawkesbury ostrich-camp and fowl-run is an incubator-house, where close on 1,000 fowl-eggs and several ostrich-eggs were seen in course of incubation. One chicken-house (brooder) contained 300 young chicks; another of the same size was nearing completion alongside. Both of these are heated by means of hot air-pipes leading from a coke furnace.

With regard to cattle and stock generally, we were informed that only pedigree stock is kept on the farm. Hawkesbury College is the largest stud-pig breeder in Australia, and we inspected a very fine collection of stud boars and pedigree pigs—about 400 in all. In 1913 about £2,000 worth of stud pigs was sold from the farm. The institution breeds all its own pigs, but imports some from time to time to give sufficient variety of strain. About three weeks prior to our visit, two Poland-Chinas had been imported from the United States of America, and five pigs of various breeds from England.

Of larger-sized stock, the College has 90 head of cattle and about 130 horses. The breeding, rearing, feeding, and management of draught-stock are amongst the chief features of the college course. Ponies, light horses, and buggy horses are also bred. The cows are both hand and machine milked.

Practically the only kind of cheese made on the farm is Cheddar. Its rate of production is one pound by weight of

cheese from 10 lb. of milk. Butter is produced at the rate of one pound by weight from 25 lb. of milk.

There is, in connection with the college, a well-equipped stock lecture-theatre, chiefly used for short courses by the veterinary surgeon. It is so arranged that, without any difficulty, typical cattle may be brought right into the hall, in front of the lecturer, and their various points indicated. Last year 117 farmers attended a short course of this kind.

A large silo has been erected on the farm for providing the stock with food. In this connection, maize has been found to be very profitable if cut up into chaff. The maize-chaff is mixed with sorghum, and the mixture is blown up to the top of the silo by an air-blast. The mixture of maize and sorghum then falls down in an even distribution for storage. This system of silage—the only system that is said to pay—is turned out at 4s. per ton, and the silage is fed to the milch cattle, mixed with hay, etc., as it does not answer when fed alone.

The only breed of sheep kept is Romney-Marsh, used for the production of stud animals.

The soil round about Hawkesbury is a poor sandstone, with a layer of iron-stone gravel, on an average, about two feet below the surface, and growing sour grass (Iridaceae). The grounds about the College extend over nearly 3,500 acres, of which about 1,000 acres are cultivated. There is a fully-stocked orchard, with an evaporator and cannery, and practical instruction is given in fruit-growing, preserving, packing, and also in market-gardening. There is, moreover, a farm of 116 acres of alluvial soil on the banks of the Hawkesbury River, and from that waterway, said to be "the most picturesque in the world," a complete irrigation system is here carried out; and students are taught along the lines of various aspects of intensive cultivation. Near Hawkesbury College is a large concrete elevated water-tank, containing river-water for irrigation. This river-water, on account of the clay in suspension, is not always fit for potable purposes, and so, for drinking, rain-water has to be used.

On our departure from the institution, Mr. Potts, in replying to a vote of thanks, reverted to what he had said at the outset, that Hawkesbury was teaching only *practical* agriculture, but that it was hoped to teach the *science* of agriculture in another 20, 30 or 50 years. The institution does not undertake botanical or entomological determinations, or chemical analyses, for farmers: these services *may* be done at Hawkesbury, but the authorities do not favour such a course, work of that kind being performed by the departmental experts stationed at Sydney. The State's chemical, entomological, botanical, veterinary, and dairying problems, says Prof. R. D. Watt,* are studied by these experts, who spend part of their time at their headquarters in the Agricultural Department in Sydney, and part in travelling round the country and giving the farmers the

* British Association Handbook of New South Wales (1914), 213.

benefit of their researches. The agricultural districts are covered by a network of experiments on private farms, superintended by district inspectors.

Other N.S.W. Institutions.

Allusion was made above to the 15 different experiment farms, other than Hawkesbury, which the New South Wales Department possesses. Two of these are, like Hawkesbury, teaching institutions, but locally specialised. They are Bathurst and Wagga-Wagga. Their main objects are to demonstrate the most economic and effective systems of producing and harvesting crops, and of determining the suitability of crops for the areas represented by these two farms. They also devote themselves to studying the improvement of cereals, and the production of highest-quality seed-wheat.

Wagga-Wagga, which comprises 3,300 acres, whereof 1,200 are used for mixed farming, 100 for fruit-culture, and the balance for grazing, can accommodate 60 resident students. Bathurst, which is 145 miles west of Sydney, accommodates 34 for a two-year course, and utilises its whole area of 610 acres for cropping and grazing; in addition to which it rejoices in the possession of an irrigation plant in full work, for 16 acres of the farm-lands lie on the rich alluvial deposits of the Macquarie River, from which the water is pumped by a Blake pump of a capacity of 14,000 gallons per hour. Both flooding and furrow systems of irrigation are practised; the former for lucerne, the latter for drilled crops, such as maize, potatoes and vegetables.

To a South African it is instructive to learn that at Bathurst, as in other parts of Australia, experiments have proved that the principal plant-food which the soil lacks is phosphatic material in an available form, and here, as elsewhere, it is said that applications of nitrogenous manure have not given returns commensurate with the outlay. It is likewise interesting to be informed that Cape barley is largely grown for green-fodder purposes, making an excellent winter growth, and the skinless barley, although quick in growth, does not withstand the cold of winter as well as Cape barley.*

Eighty acres are under lucerne at Bathurst, six to seven cuttings being obtained yearly on the irrigation area, aggregating seven tons of hay per acre. The students at Bathurst, if *bona-fide* residents of New South Wales, are charged a fee of £15 per annum, receiving free instruction during the second year if their work and conduct have been satisfactory during the first. Extra-State students pay £25 per annum during the first year, with the same concession for their second year; and if they

* The manager of Kybybolite Experimental Farm (South Australia), in his report for the year 1912-13, says that the barley-crop grown on a 50-acre block, though not sown until the first week of August, returned a heavier yield than had ever been grown on the farm before. The variety was Cape or six-rowed barley, and two bushels per acre were drilled in with 1½ cwt. mineral-superphosphate. The soil is as poor as any on the farm, ironstone nodules being right on the surface.

should, within twelve months of the completion of their course, prove satisfactorily that they have permanently settled in New South Wales, £10 out of their first year's fees is refunded to them.

Queensland,

Its Colleges and Experiment Stations.

In the State of Queensland the teaching of horticulture, arboriculture, and elementary agriculture, in all State schools, is encouraged by the Department of Public Instruction, prizes being awarded for the best-kept school-gardens, and for the best experimental agricultural work carried out by the scholars; and the Agricultural College at Gatton, also under State control, accomplishes valuable service in the training of the young men of the country for the farming profession, and for practical experimental work in agriculture. Here scientific farming and dairying are taught, and stud-stock are kept, from which dairymen and others in search of first-class stock may be supplied.

The State, moreover, owns some half-a-dozen farms of mixed type, situated in widely-separated districts. It is the function of these farms to ascertain by experiment which crops and methods of cultivation are the most suited to local conditions. The information thus gained is made available to the farmers round about. At two of these farms apprentices are taken.*

At Cairns, in the Kamerunga State Nursery, tropical products are tested and propagated; at Mackay there is a sugar experiment station, and at Yeerongpilly, on the South-coast line, experiments in connection with the prevention and treatment of outbreaks of disease in stock are pursued.

All these institutions are under the direct supervision of the Department of Agriculture. By means of all its State farms, specialised as well as more generalised, the Queensland Government seeks to demonstrate in a practical maner what the land is capable of producing profitably.

In Central Queensland, that extensive area of almost limitless possibilities, the bulk of whose 136 million acres is devoted to the raising of sheep, cattle, and horses, there are two State farms, one at Warren, 18 miles from Rockhampton, and the other—in the Emerald district—at Gindie, 178 miles from Rockhampton. The Warren farm is relatively small, comprising only about 1,000 acres, of which less than 200 are under cultivation. It is intended, as soon as possible, to establish classes in general agriculture here for a limited number of students.

The Gindie farm is about ten times the size of that at Warren, but only a small extent—about 100 acres—is under crops, mostly wheat, one of the chief features of the farm being the breeding of stock. There are 1,000 Merino sheep at Gindie, with a small stud of the Hazeldine strain, and 500 grade beef-Shorthorns. Both these farms have reinforced-concrete silos of 100

* *Vide* "Our First Half-century: A Review of Queensland Progress." (1909), 128, 129.

tons capacity, the silage at Warren consisting of chaffed panicum and green maize-stalks, and at Gindie of chaffed green maize-stalks and sorghum.

Northern Queensland has only one farm—at Kairi, near Atherton—for its 158 million acres; but in Southern Queensland, with an area of 135 million acres, there is one such farm at Hermitage, near Warwick, on the famous Darling Downs, and another at Roma, in the south-western part of the State. On all of these farms experiments are made with a view to discover the best methods of fertilising suited to the surrounding country. Here may also be mentioned the prickly-pear experimental station at Dulacca, which I have described more fully elsewhere.

General Summary.

To summarise briefly: Agricultural Colleges exist in all the States except Western Australia, and the curricula of these colleges are drawn up with the well-defined purpose of turning out men who will go on the land. In almost every State, instruction classes are available for those already actively engaged in farming, but the scattered population is the cause of these classes not being up to the United States standard. If there is one thing more than another that strikes the visitor to the Australian agricultural educational institutions, it is their thoroughly practical character: farmers, and not quasi-scientists are what they aim at evolving. Equally satisfactory is the fact that the bulk of the students come from the mercantile and professional classes.

(*Read, July 5th,* 1917.)

B. P. J. Marchand.—The announcement of the demise, at his residence, "Clairvaux," Rondebosch, C.P., on the 5th October, 1917, of the Rev. Bernard P. J. Marchand, B.A., Commissioner of the Dutch Reformed Church of the Cape Province, and President of Section D of the South African Association for the Advancement of Science, caused considerable surprise as well as sorrow throughout South Africa. Mr. Marchand was apparently in the best of health when he attended the annual session of the Association at Stellenbosch in July, and delivered his presidential address; in fact, his death followed on an illness of only a few days' duration.

The cause of education had always appealed to Mr. Marchand, and, in addition to having been chairman of the Girls' High School at Rondebosch, he had, at the time of his decease, just completed his term of office as chairman of the School Board of the Cape Division.

Bernard Marchand, who, needless to say, was of Huguenot stock, was born at Wellington, C.P., in 1853, and received his education there and in the Stellenbosch gymnasium. He headed the list at what would now be called the matriculation examination of the Cape of Good Hope University, and subsequently entered the South African College, where he graduated in 1873,

and was awarded the institution's gold medal in 1874. At that time the High School associated with the College had just been established, and Mr. Marchand, for a short while after his graduation, occupied the post of assistant master. During a series of services, conducted by the late Rev. Dr. Andrew Murray, Mr. Marchand decided to enter the Church, and, relinquishing his studies for the M.A. degree of the Cape University, he proceeded to New College, Edinburgh, where he was in due course licensed as a minister of the Free Church of Scotland. Those were the days when the proceedings before the ecclesiastical courts against the late Prof. Robertson Smith aroused considerable interest, and Mr. Marchand's own professor and friend, A. B. Davidson, was summoned before the Presbytery. Marchand was prominent amongst the students who accorded him an ovation on his reappearance in the classroom after his acquittal.

Marchand's interests, while in Edinburgh, were not confined to theology and theological controversy, but he also took the B.Sc. course, working under the well-known Prof. Crum Brown, and continuing the chemical studies which he had commenced under the late Prof. Roderick Noble, when at the South African College. He used to recount with satisfaction the share that he had in the isolation of the alkaloid betaine. These chemical studies were subsequently rounded off in the University of Berlin. Before returning to South Africa in 1882 Mr. Marchand married Miss Lockhart, of Edinburgh, and there were two children of this marriage, one of whom, Dr. B. de Coligny Marchand, now occupies the post of chemist in the Department of Agriculture at Pretoria.

Shortly after his return to this country Mr. Marchand transferred to the ministry of the Dutch Reformed Church. After two years spent as assistant minister of Mossel Bay, he was ordained to his first independent charge at Knysna in 1884, and remained there seven years. It was there that he first gave evidence of his deep interest in educational matters, and the fruits of his untiring labours in that district in the cause of education still remain in several district schools, established, through his instrumentality, amongst the poorer sections of his congregation.

In 1891 the Dutch Reformed congregation at Rondebosch was established, and Mr. Marchand invited to undertake pastoral charge thereof. The position was accepted, and held during five years, at the close of which period the responsible post of Commissioner of the Church for the Cape Province was offered Mr. Marchand by the Synod.

Into the building up of the congregation at Rondebosch Mr. Marchand entered with great enthusiasm, and here again the cause of education was strongly pressed, resulting in the establishment of a flourishing High School for Girls.

After relinquishing pastoral work in 1896, and not content with the weighty responsibilities of his new post, Mr. Marchand undertook the editorship of the official organ of the Dutch Church, and discharged these added duties for several years.

No mention has, however, yet been made in this memoir of what is rightly regarded as Mr. Marchand's life-work—the Labour Colony at Kakamas, on the Orange River. A descriptive outline of certain phases of the work there appeared in a previous volume.* For services rendered to Church and State the name of Mr. Marchand will be long and gratefully associated with that of Kakamas. What is commonly known as the "poor white" problem had for many years been becoming increasingly urgent, and the eminently *business* capacity which Mr. Marchand possessed, in conjunction with his other qualifications, made him specially fitted to deal with it. The conviction had forced itself on him that it was the plain duty of the Church to uplift the fallen and the sinking, and so he initiated the project which has since proved so successful. He had visited, in Europe, institutions in character analogous to that which subsequently arose on the banks of the Orange River, and he reiterated his views and urged his pleas before successive Synods of the Dutch Church of the Cape Colony until at length he won through in 1897, brought the church to undertake the social scheme on which he had set his heart, and thus was begun the work which has since expanded beyond all expectations, and with the assistance of Government and warm approval of all parties, has met with a measure of success worthy of all the admiration bestowed on the foresight and persistence of its originator.

His last visit to the now flourishing colony took place barely a month before his death, the occasion being the dedication of the newly-erected church at Marchand. To the cost of erecting this building he had personally contributed £200, and he had naturally been invited to deliver the inaugural sermon in this connection. As long as Kakamas, with all its ramifications and activities, endures, so long will the name and work of Bernard Marchand have a monument in South Africa.

R. H. LOUGHRIDGE.—The death is announced of Dr. Robert H. Loughridge, emeritus professor of agricultural chemistry in the University of California. The name of Dr. Loughridge had a world-wide association with that of the late Prof. E. W. Hilgard as a pioneer research worker in soil chemistry. Their connection began half a century ago at the University of Mississippi, where Loughridge was at first the pupil and afterwards the colleague of Hilgard. From 1885 to 1890 he occupied the chair of agricultural chemistry in the University of South Carolina. He then again became Hilgard's colleague in the University of California, and shared in the classical researches which made Hilgard famous as one of the world's premier soil chemists and physicists, particularly in the study of the reclamation of brack lands, the problem of maintaining and augmenting soil nitrogen, and the application of analytical methods to ascertain the reserve stores of plant food in soils.

* "An Irrigation Settlement": *Rept. S.A. Assoc. for Adv. of Sc.*, Maritzburg (1916), 327-334.

F. W. FOERSTER, AND SOME NEGLECTED FACTORS IN EDUCATION.

By Rev. Prof. J. I. Marais, B.A., D.D.

Theories of education are in our day "thick as leaves in Valombrosa." They are often bewildering in their antagonisms. If systems are an index of progress, the 19th century has made immense strides towards perfection. Yet as one studies the various theories:—

Cycle and epicycle scribbled o'er,

a longing arises for someone to unify, and something that will make for perfection and finality. Aristotle fitly closes the second book of his "Metaphysics" with this quotation from the "Iliad":

*Οὐκ ἀγαθὸν πολυκοιρανίη· εἷς κοίρανος ἔστω.**

It is the "many masters" who should be eliminated; it is the "one" we would gladly welcome.

When, therefore, I invite attention to the views of a modern educationist, not so well known as he ought to be, I trust the reader will not turn away in despair.

A word about the *man,* by way of introduction. F. W. Foerster, German by birth and training, son of a well-known Berlin astronomer, forced, after imprisonment for political opinions too freely expressed, to make Switzerland his home, attached himself to the University of Zurich, and made his influence felt both extensively and intensively, so that he has become to a large circle of admiring students their educational guide, philosopher, and friend. Research in sociology and pedagogy occupied his time and attention. A journey to England and America to study these and kindred topics gave him greater insight, a wider outlook, greater weight in the utterance of his opinions. Add to this a charming personality, a style clear and luminous, convictions which are profound, and one can understand how his influence has spread beyond his native land.

His theories may be discussed from more than one point of view. Let me confine myself to the main theme; and this will open the way for bringing into prominence some *forgotten factors in Education.*

Foerster's starting-point is to be found in the never-ending, oft-recurring, still-beginning question, "What is Education? To that question his answer is both positive and negative.

It is *not* intellectualistic on the one hand; it is *ethical* on the other.

In this he does not stand alone. From the days of Aristotle stress has been laid upon the ethical training of the child as the true aim of the teacher. Three things, according to the Stagirite, are necessary to form a really good man—natural disposition, habit (in its moral aspect) and instruction, the highest aim of all being likeness to God.

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* Many masters are not a good thing: let there be but one.

Other educationists have dwelt upon the same topic, and have warned us against a hard intellectualism in the training of our children. A mere insistence upon the three R's will lead to nowhere or else to a fourth R, Rascaldom, as Florence Nightingale is supposed to have said.

> Formally treated, as they too often have been, they are not the elements of an education at all, but merely instruments which have not seldom been put to ill use in later life. . . . The bare acquisition of the three R's is comparable to the starving birds' possession within its stomach of bits of grit and sand swallowed to aid in digestion, but with no food for the instruments of digestion to work upon.

In that curious book, "A Domine's Log," by A. S. Neill, certain home-truths are held up which confirm what has just been said: "The three R's spell futility." "Education," he continues, "should aim at bringing up a new nation, a generation that will be better than the old. The present system is to produce the same kind of man as we see to-day."

Much has been said of our own educational system. In the manifesto issued by the so-called Nationalist party in South Africa that system is condemned in the most merciless way possible. Stress is laid on a thorough system of education suited to the circumstances and character of the people—words which might mean everything, but also mean nothing. Vocational teaching is insisted upon; provision should be made for technical, industrial, commercial, and agricultural education; our schools are to be dominated by the ideals of Christian patriotism—a programme excellent on paper, but if worked out in detail, bristling with difficulties and not free from danger to the child as well as the community.

When Bishop Grundtvig undertook his educational crusade in Demark, he did not insist on all the particulars mentioned in the manifesto alluded to above. His one aim was not to impart information on all possible subjects—*de omnibus rebus et quibusdam aliis*—but to train the man, the youth, the child, to discipline the mind, to call forth the dormant energies of the soul. And he succeeded. The value of mental training was recognized by the Danish peasant. He was roused from spiritual lethargy to mental activity, and applied his new-found energies to the economic and agricultural elevation of his country. And he, too, succeeded!

By ethical training Foerster does not mean the mere inculcation of ethical principles in a dry, formal, didactic way, not an educational or ethical Code Napoleon which will open the way to an educational or ethical paradise.

Foerster insists first of all upon the proper attitude to be assumed by the educator towards the child. The man's life must tell; character is to impress character, for education is a clash of personalities, on the one side impressing, on the other side impressionable. A teacher who does not recognize the tenderness of a child's soul fails miserably in the end. Common sense is the most uncommon thing in ordinary training, sanctified common sense an unheard-of luxury. It has been well said:

Many educationists suffer shipwreck not through lack of knowledge, but through lack of knowledge of human nature, lack of knowledge of the child's soul. Many a man is a failure in society or in the kingdom of God, because in youth he was roughly handled, as a piano on which fists have been banging in order to beat out a tune.

By ethical training, therefore, is meant the development of the whole man—body, soul, and spirit. And in man the centre of all activity is the will. Kant's opening sentence in his "Metaphysic of Ethics" is: "There is nothing in the world which can be termed absolutely and altogether good, a good will alone excepted." And Foerster insists upon the formation of the will in the child. He combats very strongly, in language glowing with fervour, the views of those who, like Mrs. Stetson, sneer at the great significance of obedience in the early training of the child. While this American educationist maintains that self-suppression, the habit of bowing before authority, eventually leads to filling the world with a number of spiritless, will-less beings, the sport of every tyrant who insists upon obedience to himself and himself alone, Foerster declares that strong personalities at all times have been those who in early years have learnt to obey. For obedience teaches man to lift himself above the natural tendencies of his will. To speak of the autonomy of the will means the possession of the "auto," but not the "nomy"; an inflated self, not self-legislation; obstinacy, which is will stiffened, hardened, useless, dead. Again and again Foerster returns to this point:

The so-called "individual" will (he says) is the greatest hindrance to the development of the personality, because it is in the highest degree exposed to external influences and the stimulus of passing events. The struggle against this "peripheric will" is a means of strengthening the "central will," the real initiative in personality. . .

This so-called "individualism" he combats elsewhere in one of his most interesting books, "Autorität und Freiheit." Take a few sentences at random:—

Der Individualismus bedeutet nichts anders als die Herrschaft des absoluten Dilettantismus. . . . Ihr redet von der Autonomie des Individuums habt ihr denn auch schon einmal ueber seine Kompetenz nachgedacht? . . . Comte bezeichnet den Individualismus als die "abendländische Krankheit" an der die Europäische Kultur noch zugrunde gehen muss.

The primary lesson, therefore, is "obedience": the object, the training of the will.

It is interesting to note that another great German Educationist, the late Prof. Paulsen, of Berlin, gives expression to similar views:—

Three imperatives stand out as guideposts to all true education: Learn to obey. Learn to apply yourself. Learn to suppress and overcome desires.

He, too, insists on the training of the will. He warns against excessive physical training, so characteristic of the modern school, and quotes an old maxim slightly altered to suit the case:

Qui proficit in physicis et deficit in moribus, plus deficit quam proficit.

I might quote largely from Foerster's "Jugendlehre" upon this point, but I refrain. The main theme might be summed up in one phrase: "Nicht Moralpredigt, sondern Lebenskunde."

The mere knowledge of ethical principles cannot call forth the deeper ethical action, because the fundamental elements in character cannot be set to work by mere "abstract knowledge."

To attain that object two things are necessary—let me call them the two R's. By this I mean Reverence and Religion.

The human soul, the child's soul, is a sensitive plant—"*Maxima debetur puero Reverentia.*" It cannot be roughly handled. The teacher who does not himself bow in reverence before the altar of the child's soul will never gain the respect of the child. Goethe, in "Wilhelm Meister," insisted upon a threefold reverence—reverence for what is above us, what is on the level with us, what is beneath us. If these are to be inculcated, the teacher himself must inspire reverence. Not what he does tells, but what he is. Iron sharpens iron; character forms character.

And here the question of punishment comes in. Foerster combats the views of Herbert Spencer on this point. The latter maintains that punishment ought to be the natural result of wrong deeds on the part of the child. For instance, if a child is always late, let him suffer by being left at home; if he lies, never believe what he says; if disobedient, let the natural result of disobedience be experienced by him.

> Is it not clear that the task of parents as servants and exponents of nature is to see that their children experience the natural consequences of their deeds, and not to remove them?

This theory is superficial and dangerous. It has no moral effect. It is based on the error of considering outward nature as the standard of human life, whereas the inner life remains unchanged. Such punishment embitters but does not improve. Spencer's own definition of education as the "unfolding of our individualities to the full in all directions," "shrieks against his creed" of punishment. There is need for constant adjustment in one's views of education; need for a "moving equilibrium," as Herbert Spencer has put it. On this question of punishment and of kindred questions there is a strong revolt in our day. "My education was interrupted by my schooling," said Bernard Shaw—*nomen omen*.

"Whatever else the current system of education may do to the child, there is one thing which it cannot fail to do him—to blight his mental growth," says Mr. Holmes, certainly no mean authority.

The brutalizing effect of corporal punishment is being generally accepted. "Spare the rod, spoil the child" is a maxim as antiquated as it is untrue. The rod of Holy Scripture—the *virga disciplinæ* of the Vulgate—is something entirely different from the ordinary interpretation of the term. It is the education towards self-conquest, sacrifice, restraint, and surrender—not a

rod for the back in the hands of arbitrary and often vindictive authority.

As an instance in point, let us take the question of lying. Conventional lying is universal, and books of casuistry have been written on the subject. Foerster does not consider it right to take the lying of children too tragically at the outset. The command to speak the truth is not clear to the child's mind at once, nor is it supported by his strong natural instincts. The real question for the educationist ought to be: where is the weak point in the child's character of which lying is the outcome? To punish would be easy; but punishment in the child's mind spells brutal force—*brutum fulmen*—which has to be resisted, like a guerilla war, in secret. Nothing has been gained; we have suppressed a symptom, but left the weakness of character of which it is the outcome untouched. Most children's lies are lies of fancy, or rather of phantasy; but of course there are others. Hence the motive in each case must be laid bare, and the counteracting influence be applied. Stanley Hall has classified lies according to their origin: Fancy lies (outcome of strong imagination), courageous lies, selfish lies, pathological lies; to which Foerster adds nervous lies.

Can punishment cure the child's nature? Herbert Spencer may speak of unfolding our individualities to the full, and the Montessori system may be defined as "steps in the direction of self-realization," or, in Dr. Montessori's own words, "the development of energies latent in the depths of the human soul." But more than this is needed. The true teacher cannot develop without removing what hampers the child: self-realisation may yield a stimulus to exertion, but it must remove obstacles which retard the proper exertion of all the faculties of the human mind. Because this is not done or not properly done in the ordinary school we hear the despairing cry of earnest men: "Is there anywhere in the world to be found a school where in the place of a mere one-sided training of the understanding we might find an education, a harmonious culture of the whole being?"

There are other problems which Foerster handles with great tact and delicacy, but with a firm grasp of principles. The sex problem claims attention. And first of all we have the question of co-education. Foerster warns strongly against the *cameraderie* occasioned by constant intercourse in class or lecture room, which certainly does not improve the relations between the sexes. Prof. Sachs, of Columbia, considers the difficulty of trainng a dozen boys with such a variety of temperament, character, gifts, inclinations as great enough without complicating the problem by introducing a number of girls, with their physical and psychical peculiarities, on the scene. Foerster is emphatic on this point:

> Young girls who for years have been subject to this camaraderie are apt to take over the pleasures, the views, the manners, and even the jargon of the other sex, thereby losing that fine sense of delicacy, of womanliness, and consequently their best influence on the opposite sex.

Vom Mädchen reisst sich stolz der Knabe,

says Schiller; that utterance has not lost its force in our time. A modest reticence in speech, a modest retirement into the inner self, will bear fruit in later life. The gradual removal of all landmarks, the delimitation of established borders, leads to disastrous results.

Our sex problem is a pressing one. Is the school and college to bear a hand in solving that problem? We have revolutionized our system of Higher Education. We are to have three Universities, compared by a highly-placed official to "the three pink pills for pale people." But the problem which to my mind lies at the back of every other educational question is that of sex.

Let it be remembered that the modern child breathes in a different atmosphere from that of his forefathers. Nothing is fixed and stable in our day: reverence for authority is practically gone; everything is submitted to criticism; self-restraint is undermined; appreciation of what is highest, purest, holiest, seems to vanish. Our magazines, periodicals, bioscopes, display pictures, represent scenes which would have made our mothers blush. The night side of life and thought is the theme of many a novel—not the light side, or the right side. Sex problems are freely discussed in print, and form the theme of discussion in the playground. The purest soul is contaminated by breathing in an atmosphere radically impure. The training in what is evil and immoral goes on without restraint outside the school room. Those who have investigated the matter are appalled at the results. The age of puberty is most critical in the life of our youth, the time when,

Standing with reluctant feet,
Where the brook and river meet,
Womanhood and childhood fleet—

the age between 13 and 15, the most formative age in a boy's or a girl's life, characteristically described by Stanley Hall in his "Adolescence." New wants arise and new desires, the senses are keenly active, and the imagination is apt to run riot in what is sensual. In many cases sexual passion sweeps the youth along in a path which ends in degradation, demoralization, disease. The percentage is high of those who fall a victim to sexual temptation. Bavinck, in a work which has recently appeared, maintains that, according to some doctors, 95 to 98, according to others, 75 to 80 per cent. of boys, and 25 to 30 per cent. of girls, fall a victim to sexual evil in some form or other. On the handling of this question Foerster gives helpful advice. I cannot enlarge on this very delicate problem. I have stated it without entering into unnecessary particulars.

Lessons in hygiene and physiology wisely taught and applied, individual guidance, all these are helpful. But as Foerster says:—

Unfortunately of late a highly dangerous dilettantism has made itself master of this problem. The hard intellectualism of a former century found the chief remedy in imparting information, as though the real cause

of sexual confusion and demoralisation lay in a lack of knowledge. As though the problem were one of knowledge instead of one of power and resistance.

And at this point the question of religion in school is discussed.

Now it cannot be denied, as Du Bois Reymond has asserted:

that the newest development in natural science has its origin largely in Christianity. The terrible earnestness of this religion gave mankind in the course of ages that melancholic tendency, delving in the lowest strata of our being, which made it better adapted for earnest investigation, than the frivolous desire for life so characteristic of paganism. Thus inspiring man with an earnest desire after pure knowledge, Christianity furnished natural science what for a long period of time it had withheld.

It is the ethical power of Christianity which acted so beneficially in the region of science: that deep patience, that carefulness, that earnestness and perseverance in detail, and that scrupulousness and anxiety to enter into a question for its own sake—all these Paganism had no conception of; they are the ripe fruit of the culture of conscience through Christianity.

If these thinkers are right, there should be room for religion, "Life has either got to be religious," says Mr. Wells, in one of his last books, "Mr. Britling," "or it goes to pieces."

Now it stands to reason that religion cannot be taught at school as it is taught in a German gymnasium. Mr. Holmes is right when he says:—

The idea of holding formal examination in religious knowledge seems scarcely less ridiculous than the idea of holding a formal examination in unselfishness, and brotherly love. The test of religious knowledge is necessarily practical and vital, not formal and mechanical.

The driving force in an engine does not consist in an elaborate system of valves an of pistons, all of which must be carefully tabulated. A knowledge of all the valves and pistons does not account for that driving power, the steam. Nor does a knowledge of various theories as to generation of steam or heat as an element in the production of steam help us to realize the power in that driving force which sets the engine in motion.

Foerster, in one of his works, quotes Jeremias Gotthelf, who says:—

I knew the Ten Commandments. But what help do they give, when the soul is not known in its weakness and strength, life in its corruption and evil tendencies? The names of virtues and vices may be known, but they must be known in life in one's own soul. We need a geography of the heart, as we need a geography of Spitzbergen, and the doctrine and history of the soul seems to me as important as a knowledge of the geographical strata or of primeval mountain ranges and the history of the three sons of Noah. The child comes to know the visible and the tangible, but to the realm of spirit the key is withheld, viz., the knowledge of his own soul.

Foerster's views on this point are not narrow, sectarian, dogmatic, one-sided. But he insists on the inculcation of reverence as an element in modern education. And what is reverence but religion writ large? Again and again Foerster returns to this point. Like Ligthart, in Holland, who lately passed from us, he insists on the teacher being in life and thought and act an expo-

nent of that reverence. The true teacher must ask, not, What shall I do? but, What must I be? Character-former on the on the part of the teacher; character-reflecting on the part of the taught. I could quote passage after passage to emphasize this.

> Character is unity. How can a young man unite love and power, humility and strength, love of truth and pity, independence and sacrifice, without the help of Him who alone has combined the apparently unifiable contradictions in a powerful will? Merely ethical pedagogics without religion tears humanity asunder instead of centralizing and leading man to unity.

Holmes, an authority one cannot easily disregard, looks at the matter from the same point of view. He maintains that a child may be "mighty in the Scriptures" and yet possess no knowledge of God, because his religious sense has not yet been awakened; just as a child may have a knowledge of all the rules of arithmetic and yet be unable to solve a single problem, because his arithmetical sense is dormant and his knowledge of the subject non-existent. What is needed is an awakening, not of the sense of duty to God, but devotion to God and love to God, without which religion is vain.

These are points of view which must be taken into account when the question of religion is discussed.

I am aware that Rousseau, in the fourth book of his "Emile," has strongly vetoed religious training in schools. To examine his views here and now would be out of place. Suffice it to say that neutrality on this vital question is a principle which, if rigidly applied in the home and school, would make all teaching absolutely impossible. No teacher is neutral regarding the rules of grammar and arithmetic, in the teaching of history and geography, in the great ethical principles of right and wrong, duty and obedience.

In this connection I may be permitted to draw attention to a notable utterance in a bulletin recently issued by the Association of American Colleges. The assertion is made that—

> there is no more intrinsic reason for excluding the Bible and the literatum of the Old and New Testaments from the subjects of study in Colleges and Universities than there is for throwing out the works of Tennyson, Browning, and Shakespeare,

and that—

> the Christian Church has more profoundly influenced American civilization, and the Christian ideals have had more to do with the evolution of American life, than any of the secular civilizations of the old world.

The exclusion, therefore, of religious subjects from the curriculum means—

> an irreparable loss to culture, a calamity to human progress, and the degradation of human life.

Our educational problem becomes complicated when we consider how alarmingly cities have grown of late years. As Riehl has said—no mean authority forsooth—

> "Europa wird krank an der Monstrosität seiner Grossstädte."

With the growth of cities schools keep pace. But the growth in size is not growth in efficiency, in formative power. Cities

naturally become centres of culture, centres of science, and art, and commerce, and industries. They offer facilities which the country does not possess. But there is wisdom in the remark of Ratzel:

"So lange es Grossstädte giebt sind sie im Uebel und im Guten ihren Ländern vorausgeschritten."

There are depths of darkness amid the brilliance of intellectual light.

The very excess of light is darkness visible. There is a tendency in all countries for the poor to migrate to the larger centres of population. Every country has its "poor white" problem. In cities the housing of the poor is a disgrace to the community. Even in Holland—a country known for its industry and thrift—the condition is appalling. Fifteen per cent. of the population—I quote Bavinck—occupied houses with one room; 27 per cent. houses with two rooms. And in these families have to live comprising from 12 to 14 persons. The young are driven to the streets with all their attractions and all their allurements to evil. Let the school be as good as we can have it, these counter-attractions become sources of evil and a danger to the community. The result is that criminality among the young increases to an alarming extent. I do not quite quote statistics, nor do I enlarge. The problem is a serious one even in South Africa.

With much to admire in Foerster's theories, there is much from which I dissent. My object is gained if others are led to study Foerster for themselves.

(*Read, July* 5, 1917.)

Cannonading and Rainfall.—The view that heavy artillery discharges exert a direct influence on the precipitation of atmospheric moisture has not hitherto found much support on the part of meteorologists. The unprecedented intensity and continuity of cannonading in Europe during the last three years has, however, again given some prominence to the idea, and it has been discussed in recent issues of *Comptes rendus*.* Deslandres holds that cannonading electrifies and ionises the atmosphere to an extent which apparently influences rainfall, though not to the same extent as the great atmospheric currents and depressions; positive conclusions cannot, however, be arrived at without careful consideration of all contributing factors, especially the degree of ionisation of the air and the intensity and character of the electric field. Lemoine's comment on this statement of opinion is that if continuous artillery fire exerts any influence whatever on rainfall it can only be in respect of light rains. Sebert, on the other hand, rejoins in effect that even if intense cannonading has no direct effect on moisture precipitation it may cause atmospheric disturbances which in turn may induce heavy and prolonged rains. He commends the problem to careful investigation by meteorological bureaux and agricultural experiment stations.

* **164** (1917) [17] 613-615, [18] 663-660.

A PLEA FOR VERMIAN PARASITOLOGICAL RESEARCH, WITH REFERENCE TO SOUTH AFRICAN DOMESTIC AND NATIVE ANIMALS.

By Coert Smit Grobbelaar, M.A.

One of the main objects of this paper is to draw attention to our ignorance of the nature and life-histories of the numerous parasitic worms of South Africa, in the hope that I may enlist sympathetic co-operation with respect to the collection of material that will serve as a basis for systematic investigation. One engaged in University teaching labours under great difficulties owing to the inaccessibility to most of the representatives of these vermian parasites; and, as I have for some time past taken a special interest in the Flatworm parasites, more particularly the Trematodes, I am anxious to get all the assistance possible. Many of the forms are definitely known to be of great economic importance, and possibly many unknown forms are equally important. There is, therefore, a necessity for a complete survey of the South African forms, not merely in domesticated but also in all our native animals.

Naturally such a general investigation must, as has been the case in the past, be carried out within the walls of a University or University College, since purely Governmental institutions are merely called upon to investigate the cause of some widespread or disastrous epidemic, and hence, the broad scientific purview of the group remains untouched. Further, it is to the University that we must look for such comprehensive investigations, and, in turn, the University investigator with limited time at his disposal for research work must look to outside scientific men for help in collecting. Our purely Governmental institutions—and here I have more particularly in mind our Agricultural Colleges—have with respect to vermian parasitology to the present day confined themselves, and will in all probability in future confine themselves, to the instruction and circulation only of such work as has been done by the University scientific investigator.

At this stage of the educational life of South Africa we are about to emerge on University lines, and have every reason to believe that more attention will be paid in the training of students to original work, especially in their later years. We may, therefore, reasonably hope to have within the various Universities a band of young workers who can do much towards elucidating many problems amongst which parasitism should rank foremost in importance.

At the present day the number of known forms is very limited. Among Trematodes and Cestrodes the only recorded forms are:—

*Distomum lanceolatum, Bilharzia hæmatobia, Tænia solium, T. saginata, T. expansa, T. cænurns, T. echinococcus, T. caninum.**

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* Taken from Gilchrist's "South African Zoology."

The life-history of none of these has, as far as I know, been investigated, and even in cases which are specifically identical with other forms whose life-history has been worked out in some other part of the world, the life-history is consequently unknown in South Africa. It may be pointed out that much time may be saved and success more assured if data are collected from direct observation with respect to locality, specific hosts, and the systems, digestive, venous, or reproductive, wherein such parasites appear. Such interest can only be stimulated on the initiative of scientific men in South Africa.

It is needless to point out in detail the importance of parasitic worms from the hygienic and economic standpoints, but it may, nevertheless, be noted that the occurrence of *Bilharzia* in children within the Union is of sufficient importance to justify the compulsory teaching of such and allied forms in the schools of the country. The early acquaintance with Zoology and all-important Parasitology would further stimulate a desire for a fuller and more complete knowledge of human and animal vermian parasites and their life-histories.

But a detailed knowledge of the South African forms is of interest beyond its relation to hygiene and economy, namely, its importance morphologically. Less is known of the South African representatives than of those of any other part of the civilized world. And this is due to our common failing in deciding that anything is only of economic importance when it has disastrous effects, and then only deserving of Governmental assistance. A morphological knowledge of the group must at least help on purely scientific grounds towards the elucidation of these groups as Zoological entities. Furthermore, a comparative and somewhat complete morphological knowledge, particularly in the case of our wild native animals, will be of much value in connection with distributional problems, and assist us in working out the physiological relations between host and parasite. The existence of a wild fauna offers, indeed, splendid opportunities for the solution of such problems.

Although my main object is to stimulate interest and enlist co-operators and collectors, one's interest in the investigation of the group compels one to complain of the serious dearth of literature under which one has to labour. Let us hope that this serious drawback will receive the full attention from our new Universities at the earliest possible stage.

In conclusion, for the guidance of those who are sufficiently interested to afford me assistance in the getting of specimens, I wish to state that Trematodes occur in practically all organs of the body, and may be killed to best advantage in a hot saturated aqueous solution of corrosive sublimate, thence, after about 15 minutes, transferred to 70 per cent. alcohol. If such reagents are not procurable, a 8-10 per cent. aqueous solution of formalin may be used for killing and preserving.

(*Read, July* 3, 1917.)

NATURAL ENEMIES OF THE ARGENTINE ANT: *IRIDOMYRMEX HUMILIS* MAYR.

By Charles William Mally, M.Sc., F.E.S., F.L.S.

The excessive abundance of the Argentine ant, *Iridomyrmex humilis* Mayr., in the south-western portion of the Cape Province, Union of South Africa, attracts a great deal of attention during the summer months, and not infrequently the question of controlling it by means of natural enemies is raised. It may be as well, therefore, to give a brief summary of what is known in regard to its natural enemies, and to make suggestions with a view to stimulating observation on the subject in countries where it occurs.

In his studies of this ant in the southern United States, Mr. Wilmon Newell came to the conclusion that it was an introduced species, and that the available evidence pointed to Argentina as the place where the species originated, and he therefore proposed the popular name "Argentine Ant." In regard to natural enemies, Mr. Newell found that, in the southern United States,

> the Argentine ant is remarkably free from natural enemies, and very few of these have been noted during the course of our investigations, while even these few are of little importance. No true parasites of this ant have been observed, and apparently the only enemies are predatory ones.

An immature specimen of the cockroach, *Thyrsocera cincta* Burm., was observed by Mr. Harper Dean to capture and eat workers of this ant, and later on Newell observed the same habit in individuals of this species. Newell also records "a jumping spider" (Attidæ) and various species of the cobweb-weavers (Theridiidæ) as enemies of the ant. The latter were troublesome in connection with artificial colonies of the ants kept for the purpose of observation, *Theridium tepidariorum* being the most abundant; but none of these spiders were observed to attack the ants in outdoor colonies. Amongst birds, Mr. G. A. Runner observed an English sparrow picking up Argentine ant workers. Newell often observed the flicker, or yellow-hammer, *Colaptes auratus*, "industriously digging up shallow ant nests in lawns and grass plots," and he considers it "the most important natural enemy which this ant has in the South."

That the natural enemies above referred to are of little use is shown by the fact that in the opening paragraph of the report by Messrs. Newell and Barber,* from which the above quotations are made, the Argentine ant is designated as "the first among the Formicidæ to attain the front rank among injurious insects in the United States."

Following Newell's conclusion that this ant originated in Argentina, Mr. Chas. P. Lounsbury, while Government Entomologist for the Colony of the Cape of Good Hope, made inquiry

*Bull. 122, Bureau of Entomology, U.S. Dept. of Agri., Washington, D.C. (1913)

through correspondents in South America in regard to its natural enemies, but no definite information was obtained.

With one exception, the official entomological records in South Africa contain no reference to natural enemies of the Argentine ant. On one occasion the writer, while examining a nest of this ant in the Botanic Gardens, Kingwilliamstown, Cape Province, observed a fly pick up two ant larvæ in succession, suck out the juice and void the larval skins. In the ordinary course the only chance a fly would have of devouring the larvæ would be when a nest of ants was accidentally broken open or turned out in the process of cultivation. But the worker ants are so quick to secrete the larvæ and pupæ that the fly would in all probability go away hungry, for it seems very unlikely that it would be able to rob a worker ant in the act of transporting a larva. The writer has not observed any other instances of the Argentine ant being attacked in any stage.

Although practically immune from attack, the Argentine ant in its turn is very aggressive, and successfully attacks quite a list of insects, including injurious as well as beneficial species. In the Cape Peninsula it has maintained its reputation for intolerance towards other species of ants. In areas overrun by the Argentine ant the writer has not found any other ant except an occasional colony of *Dorylus helvolus*. On the outskirts of the infested area native species of ants are to be found. If the native species disappear as the Argentine ant increases, and if the latter continues to spread and to thrive in widely separated localities, then South Africa should gradually become a one-ant country. This suggests that, if Argentina is the place of origin, South America should be a one-ant country within the limits of the ant's life zone, unless counterbalancing forces exist.

In a lecture before the Divisional Council of Stellenbosch in February, 1915, the writer suggested that, in the absence of true parasites or diseases, the fact that on the whole *I. humilis* was not counted a serious pest in its native home could be explained on the theory that in South America there are counterbalancing species of ants—*i.e.,* species that are as strong numerically and individually and as sagacious in battle as the Argentine ant. The fact that in the countries where it has only recently become established it drives out the indigenous ants, whereas in its native country other ants persist, suggests that it has been accustomed to meeting stronger opposition in its original home than the opposition it finds in other countries. Furthermore, the fact that in certain parts of South America *I. humilis* is a more serious pest than in others could be accounted for by the absence of one or more of the controlling species.

In the writer's opinion, based on observations on this species from the economic standpoint in South Africa for several years, whatever may be the explanation for the difference in the ant's behaviour in South America as compared to that in the countries where it has become established, so far as can be determined, during the last 25 years, the respective Governments of these

latter countries should make every effort to determine the facts in the case with a view to introducing any natural agencies which mature investigations proved to be advisable.

(*Read, July* 5, 1917.)

TRANSACTIONS OF SOCIETIES.

South African Society of Civil Engineers.—Wednesday, July 11th: R. W. Menmuir, M.I.C.E., President, in the chair.—"*The Problem of sewage disposal, with special reference to South Africa*": H. C. **Kirby.** The first portion of the paper was devoted to showing how the sewage disposal problem in England arose from the necessity of protecting rivers from pollution. In the second portion the author reviewed the larger and municipal schemes which exist in South Africa to-day, including those at Johannesburg, Wynberg, Bloemfontein, Maritzburg, Queenstown, and Pretoria. The following suggestions respecting sewage disposal in South Africa were made:—(1) The septic tank system is unsuitable, and preliminary treatment on sedimentation principles more efficacious; (2) filtration and purification are necessary generally only in cases of application to and absorption by land; (3) purification of sewage containing night-soil is practically impossible, resulting in failure both at the works and on the land; (4) night-soil should be absolutely excluded in default of ample land area.—"*Preliminary route survey of the proposed north-south Transcontinental railway, Australia*": N. **Chalmers.** An account of the investigations and survey undertaken in connection with a projected railway, 1.060 miles in length, intended to link up the Port Augusta Oodnadatta line (478 miles long) in South Australia, with the Port Darwin-Pine Creek railway (167 miles long) in the Northern Territory.

South African Institute of Electrical Engineers.—Thursday, July 19th: W. H. Perrow, M.I.E.E., President, in the chair.—"*Electrification of the Chicago, Milwaukee, and St. Paul Railway*": J. W. **Kirkland.** This electric railway system is the largest and most important existing application of electricity to main line railway operation; it employs the highest direct current voltage hitherto practically applied; it employs, for the first time successfully, and on a large scale, regenerative braking. The total length of railway already electrically equipped is 582 miles. Before electrification two Mallet steam locomotives of 278 tons weight could not handle on the mountain sections trailing loads of more than 2,000 tons; now two electric locomotives of 282 tons can handle 3,000 tons, and at a much greater speed. The power is all purchased from the Montana Power Company, which has 13 hydro-electric power stations in operation. Details of power demand and cost were given, and the manner in which speed is controlled when descending heavy grades was described. After referring to the equipment and the system of overhead construction, the author, in conclusion, enumerated thirteen advantages inherent in electrification.

Thursday, August 16th: W. H. Perrow, M.I.E.E., President, in the chair.—"*Electrification of the Chicago, Milwaukee, and St. Paul Railway* (Part II)": J. W. **Kirkland.** The mechanical features of the 42 locomotives employed on the line were described, and the data given relating to the motors with which these locomotives are equipped. An exhaustive account of the control equipment was also given. A typical sub-station was described, and suggestions at some length were made for the electrification of the 125 miles of railway connecting Durban with Mooi River on the Natal railways.

Thursday, October 18th: W. H. Perrow, M.I.E.E., President, in the chair.—"*Relay protective devices*": C. J. **Monk.** The various types of relays used on the Rand Mines Power Supply Company and the Victoria Falls and Transvaal Power Company system were described, with details of their operating characteristics, and the results achieved with these automatic devices.

Thursday, November 15th: Prof. W. Buchanan, B.Sc., A.R.C.S., M.I.E.E., Past President, in the chair.—"*Overwinding and controlling devices for winding engines*": H. **Newbery.** In view of the fact that no efficient device existed for the control of winding engines so as to prevent the frequent accidents resulting from overwinds, the author devised a scheme, when a new electric hoist was being installed on one of the Rand mines, to prevent such accidents. The device had been installed only in part, but this had been in use for four months and had given satisfactory results.

South African Society of Civil Engineers.—Wednesday, August 8th: Prof. A. E. Snape, M.Sc., A.M.I.C.E., Past President, in the chair.—"*The Maraisburg Irrigation Scheme*": J. F. **Weedon.** A description of irrigation operations on the banks of the Vlekpoort River, a tributary of the Tarka River. The canals have a total length of 17.4 miles and the total cost of the work amounted to £22,000.—"*Setting out straight earthen embankments with the theodolite*": G. T. **Ritchie.** The idea to be aimed at theoretically in using this method is to set up the theodolite with the axis of the telescope in the line formed by the intersection of the two slopes of the embankment produced.

Wednesday, September 12th: Prof. A. E. Snape, M.Sc., A.M.I.C.E., Past President, in the chair.—"*Equivalent grades*": J. D. **Shannon.** Many engine sections on the older South African railways include short lengths which are much more difficult for the haulage of loads than the rest of the section, and it is consequently necessary to reduce the loads on those short lengths. It may become economical to improve these more difficult portions in order that the same load may be hauled through the entire section. The author discussed the problem of determining what the new gradient on the improved lengths, properly compensated for curvature, should be.

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Forbes, George.—"*David Gill: Man and Astronomer. Memories of Sir David Gill, K.C.B., H.M. Astronomer at the Cape of Good Hope.*" 8vo.; pp. xi, 418. London: John Murray, 1916; 12s. net.

Jollie, Ethel C.—"*The future of Rhodesia.*" 8vo; pp. 24. Bulawayo, 3d.

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NOTE ON THE RELATION BETWEEN MIND AND BODY.

By Prof. THOMAS M. FORSYTH, M.A., D.PHIL.

At the Pretoria meeting of the Association in 1915 an interesting paper was read in Section D on "The Relation of Body and Mind." The paper was written by the Right Rev. Dr. Chandler, Bishop of Bloemfontein,* and was originally delivered as the Presidential Address to the Orange Free State Branch of the Association. During the discussion that followed this address, I made some remarks on the subject which I have always wanted to elaborate a little.

The Bishop's conclusion was that, instead of a complete dualism of body and mind, or a complete unification of them without due distinction, whether in terms of materialism or of mentalism, we must substitute the conception that mind and body are related to each other as the whole and the parts, or as life and mechanism, and that each is moulded or modified through its union with the other. It is with a view to the further elucidation of this conception, especially the aspect of it that is expressed in terms of the distinction between life and mechanism, that the following brief note has been written.

The conception of interaction or mutual influence between mind and body, so long as these are regarded as utterly disparate realities, is, when thought out, seen to be a meaningless assertion. Yet recent psychology tends to return to interactionism in some form as the only possible solution of the problem.

Materialism—the theory that material processes condition consciousness but are not themselves modified or influenced by anything else than material process, and that consciousness is only a spectator of events and not an actor in them—fails to explain adequately the place of interest, selection, purpose, endeavour in the individual life. Mentalism or psychism—the theory that matter is only an appearance to mind—fails to explain sufficiently the difference between mind and matter, and how matter limits the manifestation of mind and the action of mind upon mind. Lastly, psychophysical parallelism—the theory that mind and body are aspects, subjective and objective, or inner and outer, of the same reality—leaves the two aspects, the inward feeling and striving and the outward mechanical process, side by side with each other without uniting them in terms of actual experience. Each of these theories is doubtless part of the truth, and with sufficient supplementation would yield the whole truth. But already we seem able, by utilizing results and conceptions that are prominent in a good deal of present-day psychology and philosophy, to get a mode of statement that combines in some measure the truth of all of them, and at the same time gives interactionism a real meaning.

*Rept. S.A. Ass. for Adv. of Sc.: Pretoria (1915), 280.

The function of philosophy is to explain or interpret the facts of actual experience, of which common sense gives the practical significance without clear and definite articulation. If, then, we begin with actual experience, with what is known by way of acquaintance or immediate awareness, what we find is an individual being with purposes, interests, endeavours, acting in relation to others through the medium of a body or mechanism. The nature and working of this mechanism condition and limit the activities of the individual being, and mind or consciousness manifests itself in awareness and feeling that appreciate and give meaning or significance to the conditions under which the life of the individual proceeds. But, on the other hand, the bodily mechanism is in turn continuously modified with every effort that is made, every course of action that is chosen, every habit that is acquired, every potentiality that is realized. And the modification or development thus effected in the bodily organism as the outcome of past experience becomes the basis of further activity or future experience. The conclusion that is suggested is that the distinction between mind and body is *nothing but* the distinction between effort and habit, *i.e.*, between spontaneity, initiative, selection on the one hand, and routine or mechanical action on the other hand. These are the two poles or the two phases of the actual life-experience of the individual, and *therefore* they are the two aspects of the reality which is just the living being itself. In our everyday or common-sense attitude we never think of ourselves or of others save as mind and body together, existing in the most intimate union with each other. Accordingly, when we philosophise, if we are to be in accord with common sense, we must be able to interpret mind and body—the consciousness and the mechanism—as a duality in unity, the twofold manifestation of the real, *i.e.*, the individual being acting and suffering in relation to other individual beings. The individual being is manifested as mind or consciousness and body or mechanism, because the organism consists of the tendencies, habits, aptitudes, mechanized modes of action that are the means or organs or instruments through which determinate impressions and influences are permanently possible; while consciousness is the selective interest and attention discriminating the features and apprehending the character of the conditions under which life proceeds, and by accentuating here or there in a measure controls these conditions with a view to the development of life. Psychology shows this clearly when it says that consciousness is manifested only on the basis of organized habits and in the interest of a control of material conditions to which habitual action is inadequate; or, in other words, that the function of consciousness in the economy of life is the formation of habits of action by selective attention and effort, and the supplementation of habit, when necessary, by further attention and effort.

In short, the body is literally the *mechanism* of habit, tendency, avenues of impression, lines of action, which the individual being has evolved in its struggle towards self-realization, towards fuller

life, fuller adjustment, *i.e.*, towards completer relations with other beings similarly striving towards perfected experience. And each further achievement gets embedded, as psychology shows, in the bodily organization, *i.e.*, develops further the mechanism that makes fuller experience permanently possible. That is *why* only a fine bodily organization, a fine mechanism of tendencies, capacities, susceptibilities of feeling and impression, can be the vehicle of the manifestation of a fine soul—"a spirit finely touched to fine issues." As the soul or the individual nature develops, therefore, the body develops, and conversely the development of the body, which is its organ or instrument of experience, makes permanently possible the further development of the soul.

Materialism is able to show that body conditions mind, because the body is the mechanism of tendency and aptitude which constitutes the conditions of the manifestation of mind. Psychism is able to show that body or matter is not anything fundamentally different from mind, but is mind itself in disguise, because the body is consciousness become mechanized through habit and so made crass enough to be visible, tangible, etc., *i.e.*, to be the constant or permanent medium of communication and mutual influence between one individual being and others. Parallelism is able to show that body and mind together form one reality, because habit and effort, automatism and spontaneity, mechanized action and selective attention are the two phases of the actual life-experience. Lastly, interactionism is true not as meaning causal action between two wholly disparate things, but because life is the mutual influence of individual beings through the mechanism of acquired tendency and aptitude, and there is continuous development of individual experience through the development of the bodily organization and of the bodily organization through every manifestation of individual activity. To quote, in conclusion, a sentence from already published work of my own:

> The body or organism, in distinction from the mind or consciousness, means, in the actual life process of the individual, those dispositions and habits and impulses, with their legacy from the past and potentiality for the future, which form the basis of present effort—the stuff or material of which our life is to be shaped, expressive at once of our limitations and our opportunities.

Thus there are not body and mind as two different things. There is an individual being, whose life is partly habit, automatism, mechanized modes of impression and influence, and partly effort, attention, initiative moulding, developing, transforming its own organ or instrument of fuller life.

(*Read, July* 4, 1917).

THE FUTURE OF THE BANTU PEOPLE.

By William Hay, J.P.

When the Rev. William Shaw, then Superintendent of Wesleyan Missions, about the year 1846, proposed to start from Grahamstown and visit the missionaries in Kaffirland, he asked the Governor, who then happened to be in that town, if he had any message for any of the chiefs who would be met on the journey. Sir Harry Smith replied: " No, Mr. Shaw, no message; but civilize those people, Mr. Shaw; civilize them." Mr. Shaw enquired, " Your Excellency, what is your idea of civilization?" and the Governor answered, " Oh, I don't know, Mr. Shaw—teach them to sit on chairs.

We use the word " civilization " so freely now that we fail to appreciate the Governor's difficulty.

We understand what civilization is when we do not discuss its derivation, or seek its meaning where exact definitions are required. It is the condition under which we live; under which the best of us live and move. It is the environment of European life in its best cities: the manners and moods of people who have had visions of the highest and strive to attain an unexpressable ideal. It has been generally held that it is the life that now results from centuries of strenuous effort–a mysterious something which has moulded father and son, for many generations, and which cannot be attained by any race except by such slow growth as is illustrated in the oak in one of our streets, the stalactite in the Cango cave. Until a few years ago a European would have scorned the idea that any worthy to bear that name could be other than perfect men and women. He may have occasionally sung,

> Where is one that, born of woman, altogether can escape
> From the lower world within him, moods of tiger, or of ape?

but he would also have claimed to be the best of his race; and worthy, because of his virtues—of his civilization, to occupy the highest places in the world.

There has to be some modification of these claims in these modern days:—

> If dynamite and revolver leave you courage to be wise:
> When was age so crammed with menace, madness? written, spoken lies?

We cannot help asking anywhere, everywhere, are we really civilized?

> Have we grown at last beyond the passions of the primal clan?

We may ask by the light of burning cities and the orgies of war if what we regard as our attainments—inherited and acquired—did require a thousand years to grow to perfection, and hesitate to say these can never be acquired by tribes who do not devote ages to their cultivation.

The position is of special interest to us, the white people of South Africa, where a comparatively small number of very slowly increasing men and women of European descent are living among millions of virile, and more rapidly increasing, natives.

We have regarded these people as separated from us by eons of civilization; folk who may imitate us in several small ways, but who are so far removed from us as East is from West; so far as to be rightly regarded as racially inferior; as those who will always be the governed; as our hewers of wood and drawers of water; as those who are ever to do manual labour and respect their betters, allowing us to rest where it is always afternoon, and sing,—

> Why should we toil alone;
> We only toil who are the first of things?
> Why should we only toil, the roof and crown of things?"

I propose using the short time you are prepared to listen to me now in looking at the present position of the native—the Bantu people as they are called—and enquiring as to their future position in our national life. The great mass is barbarian; let that be freely admitted. They do not "sit on chairs"; like the residents of a far off isle, they have no manners, their customs are nasty. In the mass they have hardly touched the border of what we call "civilisation." They are willing to labour for us, but they do not desire to be of us. They are prepared to take our money for valuable service rendered, but they prefer their own society and their own manner of living to anything we can invite them to. We white men, on our part, say "So may it ever be." And yet in the short time that Europeans have been in this country; in the much shorter period within which a few missionaries and others have influenced them, they have produced a few outstanding men of ability—men who, if civilization means the doing of certain things, can do those things as well as white men can. Allow me to mention three or four of these natives.

First, the Rev. Tiyo Soga, whom I first met in 1857. His father and mother were barbarians. He himself began his boy life in a sheepskin. He lived among heathen people. He also lived near a missionary—one whom his father respected, whose teaching his mother accepted. Let it be said to the credit of old Soga that he was the first Kaffir who "whistled between the stilts of a plough"; the first of his race who utilized the waters of the running brook for agricultural purposes. But he was a heathen—a blanket, or skin-clothed, Kaffir. The boy secured the attention of the Missionary Brownlee, who began his education, subsequently continued at Lovedale. When war broke out his mother fled with him, and every day gathered sneezewood and chopped it up so that at night, by the *flame* of the fire, the boy might continue to read and learn his book. In due course he proceeded to Scotland, and was the first Bantu enrolled as a student in the University of Glasgow. He proceeded to divinity studies, and was duly licensed and ordained. In 1857 he commenced his labours among his own people, dying in 1871. He was the equal of most European ministers as a preacher; he was one of the ablest of missionaries; his translation work was of the best kind; he had all the manners of an English gentleman. His biographer, writing of his death, says: "The report of it announced the departure from this world of a man of great moral and spiritual

worth. All men who understood him felt that death had created a blank which never could be filled." Mr. Chalmers, who knew him intimately, adds: "Other Kaffir preachers may arise; some more eloquent, others more brilliant, but at its best civilization can never produce another Tiyo Soga." It produced him; and his civilization was that of only one generation. What Bantu blood might have further developed we are prevented from ascertaining, because he married a European woman; and his children—who were men and women of considerable ability, may have acquired something from their mother.

Let me mention a second name—Solomon Plaatje, whose parents were Baralongs, and who is now quite a young man.

He attended the Lutheran School at Pniel, and rose to be a teacher there. At 16 he became a letter-carrier in the Kimberley Post Office, where he learnt languages in his spare time, and passed the Cape Civil Service Examination in typewriting, Dutch, and native languages, heading the list of successful candidates in each subject. He went to Mafeking as interpreter; was there during the siege, and did the work of a confidential clerk to the magistrate. The war over, he became an editor, and is now, I believe, conducting a newspaper at Kimberley. He is one of a small deputation of natives that went to England in connection with the Native Land Act of 1913, and while there he wrote and published a book entitled "Native Life in South Africa."

A book may be regarded from two points of view: its subject matter may interest us, or we may study its language and style. This book is a polemic: a strong—indeed, a *very* strong statement of the grievances Sol. Plaatje considers the natives have against the Government and Parliament of this country. As such it cannot interest a scientific association. But the style in which it is written may be worthy of attention, and I think it is. I confess it is difficult to separate the style from the matter, and am reminded of the story of a man, during the present war, in Dublin who asked another man on the street how he could get to the infirmary. The answer he received was: "Shout three cheers for the Kaiser, and you will be there in ten minutes." There are many portions of this book which, if read in Capetown or Stellenbosch, would secure the carrying of the reader quickly to the hospital. But here is an extract which may be quoted as illustrative of the writer's familiarity with the English language, of his ability to express himself in that language.

"A noteworthy occasion in connection with the campaign was our visit to the Southall Brotherhood on Sunday, March 14th. We can hardly forget the day. It was on Crocus Sunday, when thousands of Londoners went to Hampton Court in crowds to see the crocus bulbs in bloom. It was a glorious day, and we remembered it as the second day in 1915 on which the European sun shone through a cloudless sky from sunrise to sunset. Thousands of people attended at Hyde Park to witness the church parade, and still more thousands took advantage of the glorious spring day, after a strenuous winter, to flock to Epping Forest and other popular resorts."

Whatever may be the subject matter Plaatje deals with he knows how to use the English language with propriety, a language by no means easy to use. He has also made a collection of Sechuana Proverbs and their European equivalents, which deserves the commendation it has received in England. He is also the author, or joint author, of some educational works. He is a native one remove from barbarianism, and his life is yet before him. He has had the good sense to marry one of his own race, and if there is anything in heredity, we may see some clever people in that family.

The third man I mention is J. Tengo-Jabavu, the well-known journalist of Kingwilliamstown, with whom I was closely associated when I lived there. Jabavu is a Fingoe, and comes of parents who lived the ordinary native life. He attended school at Somerset East and Healdtown, and was the first Bantu to matriculate at the Cape University. His family was not well off, and to get further education he went to Lovedale, where, among other duties, he edited a small Kaffir paper published by the Mission. Dr. Stewart considered he made it too political, so they separated, he going to Kingwilliamstown, where a small committee enabled him to start the well-known paper *Imvo*. Jabavu has never written book or pamphlet; he is just a journalist and politician. He is thoughly acquainted with the British Constitution, and the leading ideas of the men who have made the Empire, especially of those who have ruled it for the last half century. He has been a keen South African politician all his life, and secured the esteem of our leading statesmen long ago. As a journalist, he has exercised very great influence, as a writer of pure sound English he has few equals. He married a woman of his own people, and one of his sons is a man who will probably do greater things for the native race than his father has been able to attempt. I refer to Professor Don Jabavu, one of the educational staff of the newly-founded Native College at Fort Hare. As this boy could not be educated in the Colony because of his colour, his father sent him to Enlgand, where he took his B.A. degree with Honours at London University—the first Bantu to attain to this distinction. He continued his education subsequently at Birmingham University, learnt the business of a printer, did work as a journalist, took some teacher's certificates. He went to America and associated himself with Booker Washington, to understand the methods of this successful administrator. Thus equipped, he is now serving his country in a most useful way.

If these men are merely sports—a few diamonds found in what is only "blue ground," there is no necessity for devoting much attention to them. But if they are the advance guard of the whole race on the march to civilization, then we have to consider our relationship to such a race.

Let it be remembered that there are not just these men—half-a-dozen or so, and then a mass of savages. A very large number of the race follows close upon their heels, and are people who would be called civilized if they were white. I might mention Dr. Rubasana—though his degree may be only

something honorary obtained in America. He has this to his credit, that he has sat in a Provincial Council. There is the Rev. John Dube, conductor of an Industrial Mission and President of the Native Congress, to which the Government has, I am told, more than once sent an official representative. There are a few barristers and attorneys. I know of one native who wished to be articled to a Capetown attorney, but this not seeming desirable, the lawyer advised him to go to England and study for the bar. The native did so, and having been "called" in England, had to be admitted to the Courts here. He then took advantage of the Colonial law, disrobed himself, and became a solicitor; thus, in a roundabout, but clever way obtaining exactly what he started out to secure.

No native has followed Soga in studying at a British University, but there are a large number of men in most Christian churches who are fully ordained ministers, and as such are doing their work in a creditable way. Taken altogether—and remembering that the man who has not seen Europe is very poorly equipped as a preacher—these men, *and their wives,* are a very influential class in this country. In this conection it will be remembered how Macaulay, in the first chapter of his History, calls attention to the influence exercised in England by the equality of both Saxon and Norman priests insisted upon then by the Church. The like equality is recognized now in Church Councils and Synods here. Then, we must remember the respectable number of both men and women who have obtained teachers' certificates, and are doing excellent work; themselves "civilized," they are civilizing the children of their race. Thanks chiefly to missionary institutions, there are now a considerable number of tradesmen; and it is only just, I think, to recognize the larger number of servants in various capacities and of intelligent mine workers, and farmers—black men who are closely following the example and instruction of civilized Europeans. Fifty years ago, when I was a young man, there was not a sheep in the Transkei; now there are thousands, producing some of the best wool grown in South Africa. That the mass of natives is not yet leavened we know; we must admit that as a whole they are content to be what their forbears have been for many generations. But there is evidence—strong and sufficient to justify the statement—that the Bantu people can become one of the "civilized" races of the world; indeed, that many have already attained to this civilization.

That being so, the method of our dealing with these people is of importance: to ourselves, and also to them. They are not all born to be wood-cutters and water-carriers. They are not barred by physical or mental conditions from benefiting from our instruction, and following our example. They may or may not have as many brain convolutions and depressions as Europeans—too few brains have yet been compared of those who enjoyed equality of education and of opportunity to determine that. So far our administration of their affairs has been at best paternal, and by "rule of thumb." What was ordered they did; what was

given them they accepted. They could keep silence in two, and three, and even four languages!

A Basuto native not long ago told his missionary that he had now solved the mystery of the two races. He said, "God once built an oven, took some clay, moulded it, and set it in the oven to bake. The result was a white man; who asked God to give him something; and God, pleased with his work, said, 'I give you everything." Then God made a second, who came out of the oven black; he also asked God for a gift. God said, 'I am sorry I cannot. I have given everything to the white man.' The black man replied, 'This is a hard thing, to live in the world with nothing'; and so God, after some consideration, said, 'There is one thing I kept back from the white man, and I give it to you. You are to have contentment.'"

But now this contentment, this docility, is being stirred up in various ways; by our influence, our teaching, our justice and injustice, and the generally quiet, persistent influence of their own leaders. Once the chief's word was law; once the magistrate spoke and none dared disobey. Once the white missionary was the guide, adviser, and friend, whom it was found wise to follow. Once the English lawyer was the only person to be consulted in connection with land and life. But now the natives are being—slowly but surely—influenced by their own native leaders, and the newspapers which everyone may read in his own tongue. These point out from time to time what they regard as "the wrongs of the Kaffir nation," and, at least, show that they can add considerably to the difficulties of the Minister for Native Affairs. He formerly carried on his administration in an easy-going Kaffir way—at best by a series of compromises. He has now to face a people who have been coached into a knowledge of their grievances by men of their own race, who are not always careful to see that they fairly teach facts. In connection with recent legislation, there is an illustration. In a book published by a native the statement is made that in European areas within the Union 76,302,503 morgen of land feed 560,000 whites, and certain stock; while in native areas, 7,356,590 morgen feed 1,500,000 blacks, with their stock; and it is claimed that the whole land should be reapportioned *pro rata* to population, because the whole area once belonged to the Bantu race. There is a science of history. The records are clear that in the Western Province area no Bantu ever lived. It was the home of Bushmen and Hottentots. In vast areas in the Colony, the Free State, and the Transvaal no Bantus ever resided. When the white men first entered and took possession they were occupied by none but vast herds of game and by wild beasts. The native land difficulty is not all due to European land hunger, but also to the large increase in the number of the native people. It is this increase, coupled with the unsuitability of the country and its conditions for European settlers, that is the real difficulty; it is because some Europeans think the natives are being persuaded by their natural leaders to seek a wider place in the sun that there are Land Bills, with their hastily drawn and unscientific conditions. The natives are much keener politicians

than the white people are. When the five volumes of the Native Commission of 1913-15 were published, at something like six guineas, some frontier natives brought the money to their member of Parliament and requested him to procure copies for them. He called their attention to the size of the books, and to the length of time it would take any one man to read them, so that to pass them round meant reading until doomsday. They replied: "They had considered all this: the nights were long; *one* could read while many listened; thus they would all know what had been said by witnesses; what had been proposed by the Commissioners." No white people have ever taken so keen an interest in the doing of Government. It is evidence that these Bantus have ability, and are alive to their own interests. And are not all the happenings of the present time proofs that they are dissatisfied with the gift of "contentment"; that they are intelligent enough to know that they have *rights*, and are entitled to *justice;* that they, and all men, were born equal—at least with the right to equality of opportunity to make the best of life.

The party politician has his own panacea for all these difficulties; but *here* we are not of these men. Our mission is the advancement of science, by which we mean, so far as natives are concerned, that to rule them rightly we must take all the facts of their life, and of ours, into careful consideration; and as carefully set forth the general principlés drawn from all those facts upon which they are to remain a part of the body politic, and continue to march along the road of progress until the race acquires all that is implied in the word "civilization."

I have said—I say again—if the few advanced natives are only sports, not to be accounted for, not likely to be followed by others we need not trouble ourselves with the native problems. We may hold that white people are here to improve the Bantu people, and be content to leave this to some other coming—and perhaps far-off time, when something will have to be done. *But* if these people are *now* attaining to civilization; if they are *now* showing that they have the ability to rapidly acquire all the arts and graces and powers of civilized life; if they are displaying intelligence and practical ability of a high order, then upon us of this present generation is laid the duty of seeing that they receive the example and assistance, we who march in "the foremost files of time" have to give. These native people will have to carry the lamp of civilization to the natives of Central Africa. How they will carry it, and indeed the kind of lamp they carry, will largely depend upon us.

General Smuts has recently informed an English audience that the natives are being governed in terms of Christian morality, which indicates a sufficiently high ideal, if it be not a present attainment; and it will satisfy most of us as being the most scientific plan that could be devised. But let us remember *that* ideal has as one of its constituent parts the simple statement that neither science nor Christian morality can be satisfied if *colour* receives more attention from those who govern than *character* does.

(*Read, July* 5, 1917.)

NATIONAL GILDS: A HINT TOWARDS RECONSTRUCTION.

By R. T. A. INNES, F.R.A.S., F.R.S.E.

(*Précis.*)

The author takes as his texts Mr. Lloyd George's injunction to "Think out new ways, think out new methods, think out even new ways of dealing with old problems and get a really new world," and President Wilson's words, "Congress has provided that the "Nation shall be classified for service in order to place men in that position which shall best serve the common good. The significance of such a step cannot be overestimated; it is a new thing in history and a landmark in our progress."

He urges that scientific men, by their training and critical attitude of mind, are not only fitted to, but should, take an active part in the policies of reconstruction. He asserts that society is gravitating towards either a "servile State" or state composed of "National Gilds," to the latter of which his own preference is given.

It is suggested that a Census of Requirements should be made annually, and that production should first of all be bent on the supply of all the requirements of the community in the way of food, housing, clothing, sanitation, etc., etc.; and that a state arranged on such a logical principle will evade or shelve the trouble between Capital and Labour.

RESEARCH GRANTS.—The following grants in aid of research have been awarded by the Council of the Royal Society of South Africa:—To Prof. M. Rindl, Grey University College, Bloemfontein, £35 for the chemical investigation of some toxic and medicinal South African plants; to Mr. J. S. van der Lingen, South African College, Capetown, £40 for continuation of researches in radiology; to Prof. J. T. Morrison, Victoria College, Stellenbosch, £100 for investigation of earth-tides; to Prof. S. J. Shand, Victoria College, Stellenbosch, £35 for a study of the alkaline igneous rocks of the Transvaal; to Prof. G. Potts, Grey University College, Bloemfontein, £25 for a botanical survey of certain areas of the Orange Free State; to Mr. K. H. Barnard, South African Museum, Capetown, £32 10s. for the collection of terrestrial and fresh-water crustacea; and to Prof. J. W. Bews, Natal University College, Maritzburg, £32 10s. for research on the plant succession in the grass veld of South Africa.

SOME PHASES OF APPLIED ENTOMOLOGY IN SOUTH AFRICA.

By Eric S. Cogan, M.A., Ph.D.

In his presidential address before the American Association of Economic Entomologists, Dr. C. G. Hewitt stated that "the activities of injurious insects, which furnish the problems of applied entomology, are more pronounced in countries where, for various reasons, the stability of the physical and biological environment is changed. This affords a reply to a question, often asked, namely, why entomologists are faced with more problems in newer countries, such as our own, than in older countries." On this quotation I would ask you to dwell for a few minutes and consider its applicability to South Africa. We are economically a young country, which is rapidly asserting itself in the agricultural world; our resources along agricultural lines are being consistently tapped, and we are well on the road to becoming second to none in respect to fruit culture and the production of grain and other crops. Our system of agriculture, unlike that of the older European countries, calls for extensive rather than intensive methods, and our problems in applied entomology are such as require attention from various sources. Our insect problems are diverse and numerous, and call for initiative, adaptability and perseverance on the part of the entomologist. The agricultural as well as, perhaps, the social development of the country is based to some extent on his activities. I do not aim to present all the many phases of applied entomology, but I wish to draw your attention to what appear to me to be important factors in the work.

The entomologist of to-day is not the old-time "naturalist," whose business it was to find the insect, study its life-history, and discover the vulnerable point in that life-history with a view to controlling the pest. Nor is he the systematist, whose sole aim was to collect insects and classify them. Applied entomology brings him into close relationship with the life of the people, with their interests and their habits. As Professor Herrick has well said, "we are fortunate in being associated with a phase of scientific work that is in accord with the modern trend of ideas and with the demands of the age. That is, we are engaged in a practical, economic and applied phase of the science."

South Africa offers a wonderful field in applied entomology, a field that is fraught with vast possibilities. We have made a good beginning, and bid fair to accomplish more in the future. We have a limited number of workers in a large field over a great stretch of country with varying geographical conditions, so that it would seem desirable that the training of the entomologist be broad and fundamental, not only along the lines of his particular science, but along those of the closely related

sciences of botany and bacteriology. An intimate acquaintance with conditions is, of course, necessary.

The science of applied entomology has made such rapid strides during the last two decades, and so many new phases opened for investigation, that one's chances of developing particular lines are boundless. Hewitt has written very effectively on insect behaviour as a factor in applied entomology, and here we have an example of what possibilities there are in developing this line of attack . The response of the Mediterranean fruit fly to a poisoned bait is but one instance of the factor, and opens up a great future in insect control.

We are accustomed to the use of certain chemicals and compounds in our control work, but we must ever be on the alert for new substitutes, which should be cheaper, and if possible, more efficient. Here the phase of applied entomology touches the chemist more than the entomologist, but it is the latter who sees the " end-point."

The exact effect of insecticides, sprays, etc., on the plants and trees is something we know little about; the reaction of the plant to the stimulus and stimuli calculated to produce desirable reactions are points worthy of our consideration.

Resistant varieties and disease-resisting plants is a subject which the entomologist must ever keep in the limelight. The use of northern spy stocks for apples against woolly aphis is but one example of what I mean to convey.

The question of parasites and parasitism is now, of course, quite an important one in its bearing on economic entomology. Last year Mr. Mally told us some facts about this phase. We realize more and more each day the great part played by the enemies of our injurious insects. Nor is it at home that we must confine our search for these friendly insects; the experience of other countries has taught us the value of going abroad for parasites and predators. Parasitic fungi, bacteria or other disease-causing agents liable to affect our insect enemies constitute an important subject in themselves.

Ecology, or the interrelationship of animals and plants, is a subject which has come into prominence recently. And it is one which it behoves us to take into consideration.

We have in our midst some injurious insects which have come from other shores—a natural result of international commerce. Many of these are recognized troubles in their " native or adopted " lands, and have been the subject of much study. But the fact of their having been investigated elsewhere need not deter us from working on them here. Environmental and other conditions account in many instances for great divergence in the activities of insects. As well known as is the codling-moth in the United States, it is still a constant subject for investigation on the part of eminent entomologists.

However, it is in the realm of humanity that the entomologist can find ample opportunity for his activities. I refer now to the rôle which insects play in their relationship to man

and domestic animals. In South Africa we are faced with a great number and variety of insect-borne diseases, many of which are obviously tropical in origin. The development of our civilization in this sub-continent is closely related with the advance of our knowledge of insects and disease. An eminent American entomologist once remarked to me "that the reclamation of Central Africa was a problem which the entomologist must solve." We now know a great deal about medical entomology, but we are far from a satisfactory solution of all our troubles, and it is this phase of applied entomology which I consider most important so far as our country is concerned. In conclusion, I shall again quote Professor Hernick: "I have been keenly sensible of the influence of the malarial mosquitoes on the energy, efficiency and accomplishment of a people. And the men now engaged in studying this problem will find themselves ingratiated into the lives of the people about them, and will add to the prestige of our profession among the people of this country."

(*Read, July 6, 1917.*)

OTHER UNIVERSES THAN OURS.—The possibility of spiral nebulæ, and particularly the great nebula in Andromeda, being independent universes, at vast distances from our galaxy, has often been discussed. Strength has been lent to this view by recently published measurements of the proper motion of the Andromeda nebula, according to which there has been no appreciable displacement for the last 80 years. It now appears, according to observations of Slipher and others, that the nebula is approaching our system at the rate of over 700 miles per second. From this it is inferred that the distance of the nebula must be immensely great, possibly even greater than that estimated by Herschel. Prof. Bohlin's view was that this nebula was only 19 light years distant from our system.

SOME NOTES ON THE COLOURATION OF REPTILES AND AMPHIBIANS FOUND NEAR KIMBERLEY, C.P.

By J. H. Power.

The colouration of an animal may generally be explained in terms of one or more of those well-known principles included under the expressions "warning colouration," "protective resemblance," "alluring colouration," etc. So far as I can ascertain, these principles have been established mainly from studies on insects, birds, and mammals, whilst the colouration of reptiles, with few exceptions, has been neglected. In this paper I endeavour to offer a rational explanation of the colouration of some of the reptiles found in the neighbourhood of Kimberley. It must be understood that the colouration of a particular reptile may not be fully explained in terms of any one principle, and, indeed, we must be prepared to find several principles illustrated in the same animal.

The most prevalent type of colouration amongst reptiles is protective, the colours of the animal harmonizing with those of its surroundings. Along with this, or replacing it, we commonly find colours which serve quite an opposite purpose, tending to make the animal conspicuous in its natural surroundings. These may frequently be described as "courtship colours," for they are specially characteristic of adults during the breeding period, and may enable the opposite sexes of a species to recognize each other.

In his book on the "Colours of Animals," Prof. Poulton says that:

> Courtship colours rarely usurp the whole surface of the body; they include everything that is most beautiful in nature, and are carefully concealed when the animal is at rest, while, on the other hand, warning colours can be distinguished by the subordination of every other feature to that of conspicuousness. Crude patterns and startling, strongly contrasted colours are eminently characteristic of a warning appearance.

One of the commonest lizards of Kimberley, called *Agama aculeata*, spends the winter on the open veld, where it lies in burrows, under stones or tins, or in deserted termite heaps. At that season of the year it is protectively coloured to a high degree. The colours of the dorsal surface harmonize well with the prevailing colours of the surroundings, and are modified as those of the environment may change in different localities. On the other hand, in summer it becomes arboreal in habit, and is a very conspicuous, gay-coloured object on the thorn-trees in the neighbourhood of Kimberley. In the case of the male, the shoulders, sides, and breast become a brick-red, and the throat a deep-blue, bordering on black, about the beginning of the breeding season. These colours diminish somewhat in intensity towards the end of the breeding season, and finally disappear altogether.

A closely related lizard, *Agama atra*, is confined to rocky habitats, being found on the kopjes, where it sits on the dark stones. In this species also, the colours of the dorsal surface

assimilate closely with those of the stones of the immediate neighbourhood. It never climbs trees, but the male assumes most brilliant colours during the breeding season, more especially on the ventral surface. The ventral surface of the adult male is ornamented with a bright ultra-marine blue, extending from chin to vent: this is very changeable, and in a captured specimen may give place to a dull mud colour in a few minutes. There is also a deep lemon colour bordered with purple and red in the inguinal region: this remains permanent during the breeding season.

Another lizard, *Zonurus polyzonus,* inhabits the same kopjes, and the same individual may occupy a particular rock crevice for many months, never venturing far therefrom. It may also be found on small ridges, but only where the vicinity offers rocks or stones with suitable hiding-places. The dorsal colouration again is entirely protective, but unlike the *Agamas,* is not capable of modification—at least, not during a short space of time—and experiments with varying light and temperature have produced no responsive change in the dorsal colours. This fact may be connected with the extremely sedentary habit of the animal: amongst the black rocks which it frequents, the shining black of its coat harmonizes perfectly.

The ventral colours of this creature are very different. The whole ventral surface of *Zonurus polyzonus* from chin to vent is brilliant red, and the rich red colours are possessed by adults of both sexes throughout the year. The reptile may often be seen perched on the top of a rock, sitting as erect as the length of his forelimbs will permit, and thus displaying to best advantage his flaming vest. It is noteworthy that on the approach of danger both the *Agama and Zonurus* hide their bright ventral colours by pressing the body against the rock or other object on which the animal may be resting. This sufficiently indicates that the bright ventral colours cannot have a warning significance.

The young of *Zonorus polyzonus* do not develop a red colouration on the ventral surface until the second or third year.

Some light is thrown on the efficiency of the life-preserving mechanisms possessed by animals through a comparison of their birthrates, the total population of a species being assumed as constant.

From examination of a large number of females I have found that *Zonurus polyzonus* produces only from one to four young, generally two, at a time, while the *Agamas* lay from fourteen to seventeen eggs at a time: in the latter case, however, there is no doubt some mortality amongst the eggs.

In the "Origin of Species," page 83, Darwin says:

> The real importance of a large number of eggs or young is to make up for much destruction at some period of life; and this period in the great majority of cases is an early one.

Regarding this as a truism, it would appear at first sight surprising that *Zonurus,* which does not possess the power of colour change, has less mortality than the *Agama* and certain of the skinks which can thus adapt themselves; yet the fact is that

Zonurus polyzonus adheres so strictly to the same environment that it has no need for such a property. The common skink, *Mabuia trivittata,* which can change from quite a sombre colour to a light reddish brown according to the colour of the surroundings, produces ten young at a time. It would appear that *Zonurus* can have few enemies that really count outside snakes, and these, at least in the Kimberley neighbourhood, are not plentiful. In any case, the habit of sitting on a rock just over the narrow cleft which forms their retreat gives them a chance of disappearing at the first sign of danger. If the snake were small enough to enter the cleft it could seize only the tail, which is turned over to shield the body, and this would break off, leaving the lizard unharmed. Birds of prey seldom or never see the bright-coloured ventral side, and the dark, almost black, dorsal colour renders them invisible against the similarly coloured rock when viewed from above.

Again, some hawks used to roost on a building in Kimberley at one time, and in searching their droppings I found the remains of several *Agamas* and *skinks*; no fragment of a *Zonurus* was found, yet I have no reason for suspecting that *Zonurus* is distasteful to birds of prey.

Whilst the dorsal colouration of these rock-dwelling or terrestrial kinds is almost always protective, that of the arboreal *Agamas* is apparently not so: it seems to belong to the type known as

Alluring or Pseudepisematic Colouration.

When the colours of an animal imitate those of some other object in order to attract its prey, it exhibits what was termed "alluring colouration" by the late Mr. Wallace, "pseudepisematic colours" by Prof. Poulton.

About November, 1906, the butterfly *Callidryas florella* was very plentiful on the veld near Kimberley, and large numbers of them were to be seen hovering over the tops of the grass and bushes. I noticed that under certain bushes numbers of wings and portions of wings of the above-mentioned butterfly were collected. I did not at the time realize the full meaning of this and did not identify the responsible foe, but I now strongly suspect that it must have been *Agama aculeata,* although it may have been a bird.

However, six years later I was fortunate enough to make the following interesting observation. One sunny afternoon in November, 1912, I was admiring a fine male *A. aculeata* displaying his beautiful head and chest on a thorn-bush. Perched there motionless, he looked like an attractive flower with the outer petals of brick red, the inner ones a blue cluster in the centre. As I gazed admiringly at him a butterfly, to my utter amazement, deliberately landed on the tip of his snout, and before I could realize what was happening he had swallowed the insect, discarding the wings—probably because they are such dusty and unsatisfactory things to eat.

When I was able to collect my thoughts, I examined the ground beneath the tree for further evidence in the shape of butterflies' wings, but found none. Of course, they could have been easily carried away by the wind or by ants.

Recognition (Episematic) Colours.

Mr. A. R. Wallace believed that one of the chief purposes of sexual colouring is to enable the sexes to recognize their kind, and thus avoid the evils of infertile crosses. This I believe is a very important factor in the colours of our *Agamas* and *Zonurus*. Very often I have seen *A. aculeata* on stones fringing the kopjes which form the retreat of *A. atra*, and on a few occasions I have seen *A. atra* on stones right in the domain of *A. aculeata*. Now *A. atra* and *A. aculeata* are rather closely allied species, and the fact that they are normally topographically separated may perhaps mean that only in this way can they permanently maintain their specific entities. If this be so, it is obvious that distinctive colouration may be of great importance in preventing intercrossing by venturesome individuals which may happen to overstep the boundary line between the two areas.

No direct proof of this explanation can be presented, but having witnessed the display of a male *Zonurus* and the approach of a female to him from a distance, it is difficult to avoid the conclusion that the brilliant red colours of that lizard serve for recognition purposes; it should be mentioned, however, that the females are coloured like the males, but not so brilliantly. In this species the males and females live strictly apart, the intervening distance between their respective retreats being sometimes as much as sixty or seventy yards: in such cases it is probable that the sexes need a means of distinguishing their kind from a distance, more especially as they live in such close companionship with *Agama atra*. The corresponding blue in the males of the latter have in all probability the same meaning. Supposing these colours did not exist, then either sex of *Agama* or *Zonurus* in search of a partner would be very often disappointed, as the manner of sitting on the tops of the rocks is identical in both. And since they orientate with the sun, the colour is seen from all points in the course of a day.

Mr. Wallace,* in dealing with colours which are an indication of sexual maturity, made the following general statement:—

> I see in the need of outward markings, whether for purposes of recognition or as preventing inter-crossing between incipient species, a sufficient cause for all such conspicuous indications of specific diversity as are found pervading the whole vast world of life.

Variable Protective (Procryptic) Resemblance.

It would appear that the power to change their colour to suit the surroundings is much more common among the reptiles and amphibians than is generally supposed.

**World of Life*, 165.

When we look at certain lizards and frogs, apart from their surroundings, we find it difficult to realize that such variegated objects can be anything but conspicuous, but as a matter of fact these very markings which we would consider as detrimental to concealment only help to make the possessor all the more secure. To those who see the creatures only in museums this general likeness to the surroundings is not evident. The concealment brought about by general protective resemblance can only be appreciated by studying nature in its natural haunts. Referring to this matter, Prof. Poulton, on page 24, "Colours of Animals," says: "We cannot appreciate the meaning of the colours of many animals apart from their surroundings, because we do not comprehend the complicated artistic effect of the latter."

The variability in colouration displayed by *Agama aculeata* in response to different surroundings is really remarkable.

A male and female of this species may occupy the same tree, but I have never noticed two of the same sex so situated. The male on such occasions goes right to the top of the tree, facing the sun. The colour dorsally is then very varied, some specimens being very light with various marblings, while others, on the contrary, are dull, possibly in sympathy with the lights and shades beneath and around. I have never noticed the female go to the topmost branches of a tree, she seems to content herself with remaining in the deeper shadows. She is then a very dark brown dorsally with slaty-blue patches here and there, having dark longitudinal vermiculations ventrally. It is noteworthy that when the colours of either sex are dark dorsally, the whole ventral surface is covered with these dark vermiculations.

On the ground even a greater range of colour is exhibited, inasmuch as all dorsal markings may become obliterated in favour of a very dark brown or a light yellow (females evidently do not possess the power of producing this latter colour), although ventrally the shoulders and chest are a brick red and the throat a deep blue, almost black. The dorsal surface of the female may be either dark brown, dull uniform grey, or different shades of reddish brown, with various markings and marblings according to the environment.

When on the ground the adults often remain quite motionless until they are in danger of being trod upon; their colour is so much in accordance with the prevailing colours of the surroundings, that an average passer-by would fail to notice them if they did not move. On such occasions the intensity of the ground colour and super-imposed light markings may vary considerably according to the lightness or darkness of the surroundings.

This chameleonic power of colour adjustment seems to be common to most of the *Agamas*. During the summer of 1908 I was fortunate enough to come upon a vivid green female *A. hispida* in a field of young lucerne near Somerset Strand. The creature harmonized so perfectly with the bright green of the surroundings that, had it not moved from my feet, I should cer-

tainly not have seen it. Another female found on the roadside at the same place was greyish brown with yellow patches on the dorsal line and on the sides. No two creatures could differ more completely in colour than these two females. A male *A. hispida* observed on a hill at Somerset West the same year was a varied green and olive; this specimen would have escaped observation also had it not been in my path. When it did move, as in the case of the two females, it was but for a few feet, and then it became motionless. I noticed that if my attention were taken from them for a moment I had some difficulty in locating them again.

I have never known *A. aculeata* to turn green; probably the aridness of its terrestrial habitat has something to do with it.

A rapid and very localized change of colour, not found in other lizards, is exhibited by the females of *Agama aculeata*, but is unknown in the males. When teased she sometimes exhibits scarlet blotches on the back at each side of the vertebral line; in these blotches the colour extends even to the tips of the scales. I noticed that these appear when the creature meets with a violent death, especially if the head be crushed, and that bearing females produce them very easily. They are perhaps calculated to have a terrifying effect on attacking foes, as presumably is the case when chameleons suddenly change colour on alarm.

The male *Agama atra* can make itself perfectly black dorsally with or without a white vertebral streak, to suit the rock on which it sits. It may also assume a light pink dotted with ocelli. The range of colour possessed by the female is similar, and in addition she is sometimes covered with red blotches, as in the female *A. aculeata*, though of a deeper red; the ground colour of the body on such occasions is a lemon dotted over with ocelli.

I have frequently watched specimens of the frog *Rana fuscigula*, which were light green adorned with a light vertebral line, leaving the water on the edge of a dam. The pale green ground broken by the dorsal streak harmonized so effectually with the soft green shadows, the reflections of the trees, and with the faded willow leaves on the side, that if I had not actually seen them leave the water it would be almost impossible to find them. They seem to fade away and become lost in the colour of the surroundings, and if the attention is distracted for a moment it would be some time before their exact position could be located again. These same specimens, when put in a box, became a uniform brown or sepia. Others, again, are often spotted with dark brown according to the light and shade of the surroundings.

Another striking example of variable adaptive colouration is found in *Xenopus lævis*. Specimens taken from dark, deep wells are uniform black dorsally; those in shallow pools, where the surroundings are bright, are usually a light sand colour; while those in dams overhung by trees where the water is fairly clear are spotted and marbled in sympathy with the light and shade.

The snake *Psammophis furcatus* furnishes a good example of

"protective colouration." The median and lateral stripes so harmonize with the grass that often I have watched a specimen disappear in a tuft, but failed to find it again. The long slender body helps to give effect to the stripes; one sometimes catches a glimpse of the white under-surface, and the beast is gone as completely as if it sank into the earth. It should be mentioned that this snake is very swift, and its colouration is permanent.

Experiments Bearing on the Colour Mechanism in Reptiles and Amphibians.

The following simple experiments were performed in the hope of obtaining some data relating to the colour mechanism: some of them, unfortunately, are inconclusive.

I put an adult male *A. aculeata*, of a dark brown ground colour dotted here and there with darker patches, into a fairly small tin box, the lid of which was close-fitting and overlapped the sides, so that light was entirely eliminated. This I exposed to the direct rays of the sun, and in 35 minutes the colour had changed to a cream ground with light brown patches and lighter vermiculations; the scales on the sides of the head green. I then removed him to an ice-chest, and in ten minutes he was a uniform reddish brown, with variously coloured scales on the vertebral line. In five minutes more he seemed quite paralysed and in a torpid state! The vertebral crest was erected about a quarter of an inch when the creature was first exposed to the heat, and remained so even in the ice-chest. *Agama atra*, when subjected to the same drastic treatment, acted in a similar way, becoming light when exposed to great heat and dark when subjected to cold.* The blue, however, of the ventral side did not change.

It is doubtful if these changes were entirely due to temperature, for when the heat became intense in the box the lizard always struggled to get out; hence there may have been a certain amount of nervous excitement. Certainly there was no question of light; the lid was so tight-fitting that I doubt if a photographic plate, inserted for the same period and under the same conditions, would have been affected.

Assuming that the colour of the animals is due to the presence of pigment cells in the skin, and that the degree of contraction or expansion of the individual cells determines the depth of the general colour, it is probable that external heat and cold are amongst the factors which modify the shapes of those cells.

I prepared three boxes lined with white, green, and brick-red paper, respectively. These I fitted with glass slides of the same colours. I put both species of *Agama* for half an hour into each box, taking care that they received reflected light only. The results were negative. I regret that circumstances did not allow me to continue the experiment for a much longer period.

When male specimens of *A. aculeata* are put into a bottle

*Temperature in ice-chest 2° C., in box 40° C.

containing cyanide of potassium they become a uniform yellow, all markings being completely obliterated, within a few minutes. A male specimen taken on the veld at midday on December 16th was this colour. After spending a short time in a box with some lichen it had become a very dull brown with darker and lighter marks, and a light vertebral streak. In trying to make it produce its original yellow, I applied an electric current to various parts of the body, and, on the following day, put it into a trough where the water was fairly deep. These experiments produced the same results: in both cases all marks became obliterated on the top of the head, which became pale green or yellow, the body assumed a reddish brown hue with various lighter vermiculations; while the most striking change of all was a broad vivid bluish-green line down the centre of the back and half-way down the tail. The colour of this line was most pronounced in places where there is a dark bar on the tail and a dark patch on the back ordinarily. This green vertebral line was also produced by allowing the water from a tap to flow down the centre of the back. A male *A. atra,* when subjected to the same treatment, became a dark pink, while the head and half-way down the back became a purple colour.

The effect of the foregoing stimulus is more or less general, for instance, an electric current applied at the extremity of the tail may produce colour effect in the head, etc. Allowing water to run from a tap on the head of the specimen seems, however, to produce a more or less local effect.

Two quite black specimens of *Xenopus lævis,* one of which was blind, were put into a white-enamelled trough in which there was about six inches of water. The surface of the water was covered with thin, white paper; in less than 12 hours the non-blind speciment was a light yellow, while the other remained a uniform black.

The physiological mechanism by means of which such a change takes place is described by Prof. Poulton* in the following way:—

> Certain kinds of reflected light act as specific stimuli to the eye of the animal, and differing nervous impulses pass from this organ along the optic nerve to the brain. The brain, being thus indirectly stimulated in a peculiar manner by various kinds of reflected light, originates different impulses, which pass from it along the nerves distributed to the skin, and cause varying states of concentration of the pigment cells. . .

In page 8 of his book the same author remarks:

> In some cases of colour in animals the chinks between the layers of tissue are kept open by films of less powerfully refractive liquids. When the tissue becomes dry the films evaporate and the colour disappears. We must suppose that the denser layers come together, obliterating the chinks and excluding the air; otherwise the colours would be more brilliant than ever, because the refractive power of air is even more than that of liquids.

After reading the foregoing I removed the epidermis of a female *A. eculeata* on which scarlet blotches were present. This I dried and put away in a book for a few weeks; at the end of

*The Colours of Animals.

that time I put it into water and found that directly it was wet the scarlet patches, which had completely faded, reappeared. These scarlet patches, therefore, are not due to the presence of actual pigments, but to the infiltration of liquid between layers of tissue which normally are in close contact. The sudden appearance of these spots on alarm is a kind of blushing in which apparently colourless lymph and not blood is concerned.

In conclusion, I must express my grateful thanks to Mr. John Hewitt, for his kind advice and help in the arrangement of this paper: without his assistance these notes would not have been published.

National Research in America.—Major R. A. Millikan, Vice-Chairman of the United States National Research Council, has issued a condensed statement reviewing the Council's activities. Much of this work has been allocated to various committees. The physics committee has delegated to a number of groups over 20 large problems, some of which, including the location of aircraft by sound, and the development of improved methods for measuring muzzle-velocities, have now been solved; the chemistry committee has perfected an elaborate organization for handling all chemical problems arising in the army and navy; the psychology committee has formulated a vast programme for the selection of officers for the army and the classification of drafted men; the medical committee has engaged many medical men in medical research problems and in the sanitary work of the army; the engineering committee has perfected devices for protecting ships from submarines. On the recommendation of the nitrate committee the Government is spending large sums on the erection of a nitrate plant; the gas warfare committee has had 120 chemists working for six months on the problems of gas warfare; the optical glass committee has developed the production of optical glass in six months from nothing to 20,000 pounds a month, and in two months more this figure will increase two to three-fold; the psychiatry committee has established a laboratory for studying shell-shock, and the foreign service committee has saved months in putting the United States abreast of the European situation regarding modern scientific methods in warfare.

A SUGGESTED MECHANISM FOR THE INHERITANCE OF ACQUIRED CHARACTERS.

By Thomas F. Dreyer, B.A., Ph.D.

A great deal of courage is required to express open doubt as to the truth of Weismann's theory of germinal continuity—a theory which is upheld by the majority of present-day zoologists. Respect for its originator and admiration of his devotion to his work to some extent restrains criticism by a younger generation, but doubts as to the correctness of the theory have been and are frequently expressed.

The acceptance of Weismann's theory is one of the greatest stumbling-blocks to the Lamarckian, and it is essential that everyone who is interested in the subject should constantly bear in mind in how far it is supported by observed fact.

Such support is difficult to find, and far from convincing:—

1. The fact that any particular individual tends to resemble its parents is most simply explained by assuming a germinal continuity; the apparently simplest explanation is, however, not necessarily more correct than any other. The one most likely to be true will be not the simplest, but the one which is most strongly supported by other observed facts.

2. The germ cells are, in a few cases, segregated from the somatic cells at a very early stage of segmentation of the ovum. On the other hand, in many groups—*e.g.*, in the Vertebrata—the germ cells are segregated at a very late stage of development. Further, the cells from which other tissues are derived may also be segregated from the rest of the segmenting ovum at a very early stage; but will anyone on that account speak of the continuity of such tissues?

3. It has been more or less proved that the chromosomes are continuous for successive generations, and the analogy between the divisions of the maturing germ-cell chromosomes and the distribution of mendelian factors seem to indicate that the chromosomes are the hereditary substances. Also the fact that the hereditary influences of the father and mother are equal points to the chromosomes as the carriers of these influences, since it is supposed that they are the only substances received by the progeny in equal proportions from the two parents. That the chromatin is a possible candidate for such a rôle cannot be denied, but it is not the only candidate. In cell-division the linin is also apparently exactly divided, and in the genesis of the germ cells it is quite possible that equal amounts of linin are contained in the large ovum with its diffuse linin and the small spermatozoon with its condensed linin in the form of a "head-piece," metachondria, etc.

Anyway, the consensus of opinion is strongly against Weismann's assumption that the chromosomes of different tissues of any particular animal differ from each other. It seems to be more or less proved that the chromatin in any animal does not vary; and if this view is correct, then we must assume that an ovum differs from other cells, in that its cytoplasmic constituents are different.

But if the specific nature of the ovum is to be found in the non-chromatic part of the ovum, then either the ovum must contain some other substance, continuous in the same way as the chromatin, in virtue of which the specific substance is formed in the ovum; or the specific substance must be formed in the ovum as a result of its position in the whole body. That is, the continuity of the chromatin is not a sufficient phenomenon, since we must necessarily assume a second substance which may be continuous or formed anew in each generation.

That the second necessary substance is of vital importance is indicated in the case of ova with little or no regulatory power —*e.g.*, in the eggs of ctenophores in which slicing of any portions of the ovum results in the absence in the adult of the portions sliced.

And if at least two substances are necessary for development, of one of which it is impossible to say whether it is continuous or not, how can one say that the hereditary substance is continuous?

From the above it will be seen that the case in favour of germinal continuity is not particularly strongly supported by facts. It is, however, still further weakened by definite experimental evidence. For example, the slicing experiments on ctenophorean ova indicate that the " factors " for the adult characters are present in the cytoplasm and not in the nucleus. Further, the experiments of Nägeli on alpine plants brought to Munich, Schmankewitsch's experiments on brine-shrimps, the experiments of Standfuss and of Fischer on pupæ of butterflies, and Brown-Sequard's experiments on guinea-pigs, all show that the germ-plasm is not a continuous substance, isolated in the soma. Experiments of this kind are usually dismissed with laboured explanations in terms of Weismann's theory; but anyone who is prepared to dismiss from his mind any ideas as to the theoretical impossibility of acquired characters being hereditary must acknowledge that the experiments are convincing. The scope of this paper is not such as to allow a discussion of all the cases mentioned, but a few words on one of them, viz., those on butterfly pupæ, may be allowed. The germinal discs and gonads in such cases are already present before pupation. If, now the application of heat or cold to the pupa should change the characters of the imago, then, the changes not being of the nature of secondary sexual characters, these changes must be acquired characters—*i.e.*, characters acquired by the soma under direct stimulation of the environment. And if, as actually happened, these changes reappeared in some of the next genera-

tion reared under normal conditions, then the changes must be definitely hereditary. It is claimed that the altered conditions acted directly on the germ-plasm, which then altered the soma; such an argument is inadmissable, since the two substances are already segregated at the time when the experiments commenced.

There is, moreover, a most important theoretical objection to the theory of germinal continuity—one which Weismann has already pointed out—viz., the difficulty of explaining why the germ-plasm should alternate between periods of germ-cell formation and periods of soma formation. Weismann established a theory as to the nature of polar body extrusions to account for this cyclical development, but he had to abandon his theory when it was demonstrated that spermatozoa passed through an homologous process.

It may also be added that the theory of germinal continuity is quite devoid of experimental proof. I am not aware that anyone has already pointed out in what manner such proof may be given, but it seems to me that the truth or otherwise of the theory should be capable of demonstration. If, for example, an organism be brought under new conditions and it acquire new characters which are not hereditary, will the hereditary characters appearing at some later stage be in the same direction as the acquired character, or will they be unconnected with such characters? We should expect that a certain environment acting on the *soma* will result in something different from what would be produced by the action of that same environment on a different substance, viz., the *germ-plasm.* Has such proof been advanced? On the contrary, apart from sudden mutations, not referable to changes in the environment, it is always the acquired character which later on is found to be fixed in the race (*vide* experiments mentioned above).

It may perhaps be thought that the occurrence of mutations in nature is a case such as is called for above; that an animal or plant living under certain conditions varies about a mean as a result of the interaction between the environment and the soma, but that such animals or plants occasionally throw sports which may be considered to be the result of the interaction of the environment and the germ-plasm. To such a view one must answer that occurrences in nature cannot be adduced in place of controlled experiments, since we know too little about the varying conditions in the former case; that mutations apparently only differ from fluctuations in that they result from *early* interference with normal development; that the necessary experiments should be made on successive generations at the same stage of development.

But if we are to suppose that the substance or substances in virtue of which development takes place is not continuous—that is, that it is formed anew for each generation—how are we to imagine that it occurs?

The germ-cells are without doubt highly differentiated cells.

Weismann ascribes their specific character to the nature of the germ-plasm, which he believes to be the chromatin. At present we believe that the chromatin is not specific for different tissues, and we must look for the characteristic substance in the other cell-constituents, viz., the linin, cell-sap or the yolk.

Of these four bodies, two, viz., the chromatin and the yolk, are discontinuous, whereas the other two, namely, the linin and the lymph, are continuous throughout any particular animal.

If, now, we should accept the theory that acquired characters may be hereditary, it seems obvious that the mechanism for the process must be sought in the linin or the lymph. In this connection one is at once reminded of Nägeli's theory if one imagines the continuous linin network to be his idioplasm. The theory seems to be supported in that the linin is, in cell division, divided up between the daughter cells just as the chromatin is divided; the results of mendelian experiments are therefore explained equally well, whether we take linin or chromatin to be the carriers of the mendelian characters, except that sex seems to be a character carried by chromatin. But when we attempt to form a conception of the manner in which a change in the peripheral linin may be passed on to the centre, and appear again at the same peripheral point in the next generation, we are faced by a blank wall, for such a conception is quite impossible of achievement. The linin substance is therefore not suitable as a possible carrier of acquired characters. The other continuous substance—the lymph—must also be discarded, since it has no definite structure—it circulates, and therefore offers no explanation of the localization problem.

Neither is the body for which we are looking chromatin; for histologists claim that the chromosomes are definite entities more or less invariable through successive generations. At least, we have no proof that they are differentiated anew in each generation, which should be the case for bodies "carrying" acquired characters.

There remains, then, yolk, and in the case of this substance it is possible to elaborate a very plausible theory as to how acquired characters may be inherited. This theory might be appropriately be called:

The Metabolic Products Theory of Heredity.

We know that the various tissues of the body are characterized by very different metabolic products. The metabolic product of the ovum is the yolk, and the yolk of different groups of animals is very variable in consistency, taste, etc., so that it is a possible assumption to make that the yolk in each species is specific.

There must be at least two factors in the deposition of yolk, viz., some body in the ovum to act as a catalyser for the synthesis of the yolk, and secondly, compounds capable of being combined to form yolk, in the lymph.

This catalysing substance or enzyme can be accepted to be

the chromatin, the enzyme nature of which has been emphasized by several modern biologists—*e.g.*, by Loeb. The enzyme need, for any one animal, not be different in the different tissues—in ontogeny there are no indications that the chromatin is differentially divided in the way postulated by Weismann; in fact, Korschelt u. Heider ("Entwickelungsgeschichte der Wirbellosen Thiere") say that this assumption of Weismann is one of the strongest objections against his theory. Let us therefore assume that the chromatin in all the tissues is the same substance throughout, and that it is an enzyme.

When we, then, consider the linin, we are absolutely forced to decide that it is the substance which must be labelled living. Living organisms are characterised as being sensitive—the organs of sense are invariably free projections of linin threads, in the form of cilia, flagella, rhabdomes or hairs. Living organisms are characterised as contractile; the contractile substance, the myofibrillæ, is again linin, somewhat modified apparently in composition. Absorption of substances in solution by living organisms differs from osmosis in the highly selective way in which it occurs—the absorptive surface is invariably formed by the thickened free ends of the linin threads. A highly characteristic phenomenon of animal life is the nervous processes—these are all resultants of changes taking place in specialised linin fibres, the neurofibrillæ. The linin, then, is the unstable, the protean, living substance which is synthesised by the enzyme chromatin whenever the lymph in the neighbourhood of it contains the necessary constituents.

The lymph is a watery fluid containing various substances formed as a result of the metabolism of the different tissues; these substances will naturally be integral fragments of the living molecules from which they have been derived, so that they will vary among themselves in the same respects as the parent tissues differ from each other. Besides these there are in the lymph also those substances obtained as food through the alimentary canal.

In giving the foregoing sketch of the structure of the living substance—*i.e.*, of chromatin, linin and lymph—I have simply given expression to the results of modern histological research; but if I am to elaborate my theory, I must now make an assumption for which there is as yet no support whatever, viz., that the yolk found in all ova is a combination of the radicals derived from the various tissues. That this is not a wildly improbable assumption is indicated by the apparently specific nature of the yolk of different animals and by the extreme complexity of the yolk molecules.

If we review the various kinds of tissues, it is clear that they differ in their linin; the linin of nerve cells apparently differs from the linin of muscle cells in that it is able to select from the lymph specific radicals. This ability of the linin of different tissues to "select" radicals is not merely a function of their position, for embryological research has clearly shown

that it is due to differential division of some cell constituent. This constituent cannot be either chromatin or lymph, and must be the linin. We must therefore suppose that the linin of the ovum is, in segmentation, divided differentially in the way sketched by Weismann for his germ-plasm.

But what is the linin of the ovum? When we consider that the distinctive character of each tissue is a linin compound, and that the yolk is the distinctive character of the ovum; that, moreover, fibrillæ are mostly absent from ova, we must conclude that the yolk is a linin compound of the ovum.

The further course of events I imagine to be as follows: The yolk, like all linin compounds, is irritable, and continually some of it will be deprived of certain radicals and rise above the heavier unaltered yolk, so that the first horizontal division will be a differential division. After gastrulation the stimulation of the inner cell-layer will be different, and another kind of radical will be split off from the yolk. This process will be continued until all the tissues have been formed and come into function. As soon as this happens the lymph will contain all the radicals necessary for the formation of yolk, and those cells, which, on account of their ancestry—*i.e.*, which have, during the process of differentiation, retained certain necessary radicals, will now select the lymph radicals required, and build up the same yolk compound as was present in the previous generation of germ cells.

Imagine an ovum with yolk L A B C . . . . X Y Z. Let this give rise to the tissues L A, L B, L C, etc. Let the functioning of the tissue L A set free the radical A in the lymph, whilst the enzyme chromatin, in the presence of other L A, rebuilds more L A from food radicals in the lymph. Let L G be the linin of the germ cells, and let L G, if the necessary radicals are available, be able to build up L A B C . . . . X Y Z again. Now suppose the environment changes in such a way that the tissue L A. becomes changed to L(A + a); then the functioning of that tissue will set free in the lymph (A + a), and the germ-cell linin, L G, will now build up a new kind of yolk, L(A ± a) B C . . . . X Y Z. In development, this yolk will no more form the previous tissue L A, but the new one L(A ± a)—*i.e.*, the acquired character (± a)—has become hereditary.

(*Read, July* 6, 1917.)

Horse Chestnuts for Munitions.—The services of children are now being utilised in Great Britain for the collection of horse chestnuts intended to be used in the preparation of munitions. According to present indications, the Ministry of Munitions will receive at least 25,000 tons of nuts, representing about one-eighth of the country's total crop for the season. Every ton of nuts thus gathered means the saving of half a ton of grain.

NOTES ON THE GENUS *MYSTROPETALON* HARV. (BALANOPHORACEÆ).

By Rudolf Marloth, M.A., Ph.D.

(*With one text figure.*)

The Balanophoraceæ (order Santalales) form a family of root parasites of about 40 species, which occur in various parts of the world. They are all very remarkable plants, with regard to their general appearance as well as their floral structure, and the representatives of the various countries differ from each other very considerably in both respects. There are two genera in South Africa, viz., *Sarcophyte* in the Eastern Province (*S. sanguinea*) and *Mystropetalon* in the West.

When Harvey established the genus *Mystropetalon* in 1839 he distinguished two species, naming them *M. Thomii* and *M. Polemanni.* In 1913 Professor Harvey-Gibson (Liverpool) gave a full account of the genus, together with an exhaustive study of the anatomy and morphology of the underground as well as the aerial organs of the plants. As, however, the specimens which he had received from Mrs. Julia F. Solly (Knorhoek, near Sir Lowry's Pass) did not quite agree with the descriptions and illustrations of the two species as published by Harvey, and as no type specimens of Harvey's appear to exist (there are none in Harvey's herbarium at Dublin, nor in the Government herbarium at Capetown), the author established a third species, naming it *M. Sollyi.*

Since then specimens of *Mystropetalon* were repeatedly sent here by correspondents who wanted to have them named. It was during the attempts to do so that I realized the unsatisfactory condition of our knowledge of the morphological characters of these plants and the desirability of further investigation.

In the recently published second part of Volume V, Section II of the " Flora Capensis " (1915), C. H. Wright (p. 214) selects two characters in which, according to their authors, the three species most prominently differ from each other, viz., the shape of the anterior bract of the male flower and the shape and margin of the female perianth, thus obtaining the following combinations:

1. Male bract oblong; perianth subglobose, shortly trilobed (*M. Thomii*).
2. Bract spathulate; perianth tubular, trifid (*M. Polemanni.*).
3. Bract spathulate; perianth subglobose or campanulate, multifid (*M. Sollyi.*).

The fourth combination, viz., " Bract oblong; perianth tubular," has not been described or named as yet, but it so happens that just this form has been figured in Marloth, " Flora of S.A." Tab. 40, as *M. Thomii.* If the other three combinations are specifically distinct, then the fourth one would have to be recognised as well, and, following the example of the other cases, to be named

after its discoverer. As will be seen further on, I do not intend to do that.

Harvey-Gibson arranges the floral characters of the three species in a tabular statement which I venture to reproduce. Before doing so, however, I should like to refer to some of the points of comparison in Harvey-Gibson's table, as this will simplify matters and save repetitions later on.

Point 3. *The Anterior Lobe of the Perianth of the Male Flower.*—In young buds of all specimens examined I found the three lobes nearly of equal length and the perianth tube straight (at that stage the three segments form a tube). When the time of opening approaches, the claws of the two posterior lobes lengthen more rapidly than that of the anterior one, thus producing the downward curving of the flower. The tension between the two longer and the one shorter segment becomes finally so great that the segments separate; the blades of the two upper segments generally remain connected, while the free lower segment curves back. Naturally this lobe is shorter than the two others, but the difference in length varies in the same spike. No specific distinction can be based on this feature of the plant.

Point 4. *Lamina of the Perianth Lobes of the Male Flower.*—A distinction is drawn by Harvey between "slightly concave" (*M. Thomii*) and "very concave" (*M. Polemanni*). In all the specimens examined, including Bolus, No. 7465, which has been named *M. Polemanni* at Kew, I found the lamina "slightly concave" or just "concave," and Harvey's specimen, on which it was "very concave," was just a slightly different form. Such differences cannot have specific value when other characters vary much more.

Point 5. *The Pollen.*—Harvey describes the pollen grains of both species as possessing "fluted angles," and figures them thus for *M. Polemanni.* On none of my specimens (I may have examined at least 50 from different localities, all in a fresh condition), were the angles fluted. Judging, however, from the outline of the grains as figured by Harvey, it appears that these had undergone considerable shrivelling and contraction (perhaps by desiccation or by the action of strong alcohol), and that the edges had become furrowed during this process.

By staining the fresh grains I have found that the rounded edges of the cubical grains (this is the most common shape) contain two parallel strands, and in some shrivelled grains I have observed a slight depression along the edges. Under the circumstances one feels compelled to discard Harvey's figure and to look upon Harvey-Gibson's Fig. 6*a*, and Marloth, Tab. 40, Fig. 6, as more correct.

Point 10. *The Shape of the Ovary.*—This is said to be either ovoid or oblong. Both shapes occur fairly often on the same plant.

Point 11. *The Stigma* is described as "discoid," or "not swollen," and for *M. Sollyi* as "trilobed." All the plants which I have examined when in anthesis (before any male flower opens)

had a more or less capitate and trilobed stigma. On plants with open male flowers the female perianth and style are always shrivelled up, and the stigma may appear, even after soaking in boiling water, "not swollen."

By excluding these five points from the statement of the characters as given by Harvey-Gibson one obtains the following reduced table:—

	M. Thomii.	*M. Polemanni.*	*M. Sollyi.*
I. MALE FLOWER—			
1.	Anterior bract oblong.	Spathulate.	Spathulate.
2.	Posterior bracts, two-thirds length of anterior.	Spathulate, half the length.	Spathulate, quarter (*in my material half to two-thirds.*)
II. FEMALE FLOWER—			
6.	Anterior bract oblong. (*Harvey shows it rather broadly cuneate*).	Spathulate (in fig.)	Spathulate, lanceolate.
7.	Posterior bracts much longer than anterior stage.	Spathulate, equal to anterior (*in stage*).	Spathulate, shorter than anterior. *but not when in fruit.*)
8.	Perianth subglobose or ellipsoid.	Tubular.	Subglobose or campanulate (*or tubular, two diam.*)
9.	Perianth margin tri-lobed.	Markedly trifid.	Multifid.
III.—To these characters we may add from Harvey ("Flora Cap." II)—			
12.	Male flowers dark red or brownish; anterior bract of nearly equal breadth throughout. Bract orange.	Flower bright carmine. Bract orange.	

Note.—The words in italics are added here.

It will be a convenience to the reader to have the results of my observations arranged in a similar way. The material examined consisted of—

1. Fresh plants gathered at various times or sent by correspondents from various localities (Baths at Caledon; Steenbras Valley; Sir Lowry's Pass).
2. Bolus's specimen, No. 7,465 (a medium-sized plant, but there is also a smaller one on the sheet). This was distributed as *M. Thomii*, but renamed *M. Polemanni* at Kew.
3. The co-type of Harvey-Gibson's specimens of *M. Sollyi.*

When the two plants collected by Mrs. Solly were preserved in formaldehyde by Dr. Froembling for transmission to England, he sliced them lengthways, one-half of each being sent away and the other piece of each kept here. These two counterparts were kindly placed at my disposal. The results are:—

A (co-type of *M. Sollyi*).	B (*Herb. M.*)	C. (*Herb. M.*)
1. Spathulate.	Spathulate, with broad or narrow claw.	Spathulate, or broadly cuneate, or elongate-obovate.
2. Variable, half to two-thirds.	About half.	About half.
6. Oblong, or lanceolate.	Oblong.	Lanceolate.
7*a*. (Flower of young plant). Bracteoles shorter than bract.	Shorter.	Much shorter.
7*b*. (Older plant, with male flowers open) equal.	Longer.	Much longer.
8. Subglobose or campanulate, or tublar, up to 2 × as long as wide.	Campanulate or subglobose.	Subglobose.
9. Uniformly denticulate, but some also with three deeper indentations.	Trifid.	Tripartite, segments truncate and finely denticulate.

D. *Bolus, No.* 7465, *and Marloth, Tab.* 40.	E (*Herb. M.*).	F (*Herb. M.*).
1. Elongate-obovate or spathulate.	Spathulate.	Broadly spathulate or elongate-obovate.
2. Half.	Half to one-third.	Two-thirds.
6. Lanceolate.	Oblong.	Oblong or lanceolate.
7*a*. Shorter	Shorter.	Shorter.
7*b*. Equal or longer	Equal.	Longer.
8. Tubular.	Shortly tubular (length 1½ diam.).	Tubular (length 2 diam.).
9. Three triangular or linear or narrow and acute teeth.	Trifid.	Trilobed, the teeth bifid.

These six specimens would represent:—

A.—A combination of *M. Sollyi* with *M. Thomii* and *M. Polemanni.*

B.—*M. Sollyi*, but with the female perianth of *M. Thomii.*

C.—*M. Thomii* and *M. Sollyi.*

D.—*M. Polemanni*, but the male bract partly of *M. Thomii.*

E.—*M. Polemanni*, but the female perianth much shorter.

F.—*M. Polemanni*, but teeth of female perianth different.

It will be seen that not a single plant, even not the co-type of *M. Sollyi*, entirely agrees with one of the three diagnoses given, and that if the three species as published are to be maintained, our specimens would represent six other species.

My study of the various specimens mentioned and of a good many others had brought me to the conclusion that there was only one species, but as Harvey's original publication was not accessible to me here,* I had to wait until I obtained copies of his illustrations. When these arrived, I found my views fully confirmed, for *M. Thomii* and *M. Polemanni*, as figured by Harvey, merely represent two extreme forms of the species. This was in 1915.

In March, 1916, Dr. W. Purcell spent some time at Caledon, and kindly undertook to make some further observations on the biology of the plant.

This induced him to examine a considerable number of specimens in order to ascertain their correct specific name, but finding some difficulty, he brought me his notes, when I showed him my notes and the conclusions I had come to.

How elaborate and detailed Dr. Purcell's observations are will be seen from the notes on two of the specimens, which we insert here with his kind permission:—

No. 201 (collected March 15, 1916).

Leaves.—The uppermost: glabrous on upper side, channelled with a prominent midrib, convex on the lower side, the apex very obtuse, the surface hairy, margin ciliate.

Male Flower (Open).—Anterior bract generally more or less spathulate, with a broad claw, sometimes almost broadly linear, and then scarcely wider at the apex than in the middle (in the buds sometimes with a narrow claw), about half the length of the perianth, the posterior bracts about half or two-thirds as long as the anterior.

Female Flower.—Bloom over,, but the anterior bract still longer than the others, varying from broadly linear

* The "Annals of Nat. History" are not the same publication as the "Annals and Mag. of Nat. Hist.," although so quoted by *Eichler* (De Candolle's "Prodomus"). The latter title appears for the first time in 1841, this journal being the continuation of the "Magazine of Nat. History." The "Annals of Nat. Hist.," in which *Harvey* published his descriptions in 1839, are not represented in the South African Public Library.

(oblong) with a broad, very obtuse apex to lanceolate and an obtuse apex, ciliated at the margin and densely hairy on the lower side, especially at apex and along the broad midrib. Perianth usually subellipsoid or oblong or cylindrical.

(These characters would make this to be *M.Thomii* and *M. Sollyi.*)

No. 205.

Leaves.—Similar to No. 201, but mostlty glabrous on the lower side.

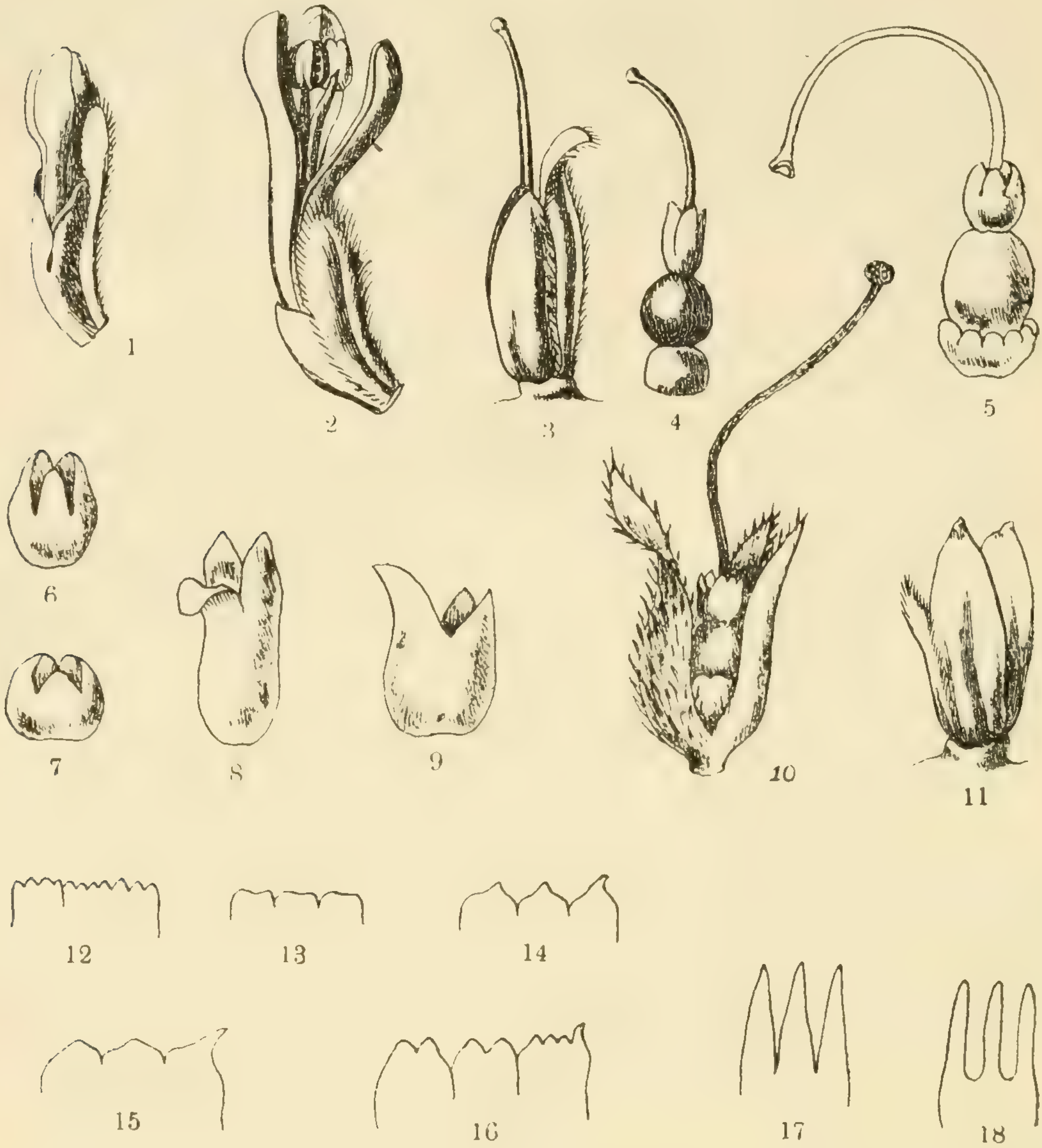
Male Flower (Buds).—The lowest with the anterior bract spathulate and two-thirds the length of the perianth, the posterior bracts nearly two-thirds the length of the anterior.

Female Flower (in anthesis).—Anterior bract broadly linear or nearly oblong or subspathulate, with a broader apex. Perianth shortly oblong (nearly 2 $\times$ diam.) to subglobose or subcampanulate, the lower lobe curving outwards, rarely quite globose, and as long as wide (including the lobes). The tube of the perianth as long as or shorter than its width; the lower lobe longer than the other two, equalling or much shorter than the tube, all generally much broader at their base than long, sometimes obsolete. The lobes sometimes entire, but generally truncate and dentate or crenate; in very short-lobed forms the perianth may appear obliquely truncate and multi-crenate. (This would be *M. Sollyi,* but the perianth is sometimes distinctly tubular, the margin not rarely trifid, the teeth entire.)

Dr. Purcell's other specimens gave equally variable results, hence from his observations, as well as from my own, one must draw the conclusion that there is only one species of *Mystropetalon* known, and that the differences observed do not even justify the establishing of two or more varieties—one can only speak of forms.

When I had written out these notes and began to prepare the references to literature, I noticed in the recent part of the "Flora Capensis" (Vol. V., Sect. II, 215) that Eichler had treated the genus in one of the later volumes of De Candolle's "Prodomus," viz., vol. xvii, 125 (1873). On looking up his elaborate account I found that he had surmised the identity of the two species, as all the material at his disposal agreed more or less with *M. Thomii.* Eichler says:

"The distinctions drawn between the two species with regard to the bracts are hardly borne out by Harvey's own figures, and the remaining differences are not quite constant, hence there is probably only one species."



MYSTROPETALON THOMII HARV.

1. Bud of male flower, with bracts.
2. Male flower, open, with bracts.
3. Female flower, with bracts.
4. The same, without bracts. (Figs. 1-4 from Marloth, *loc. cit.*)
5. Female flower of *M. Thomii*, as drawn by Harvey.
6 and 7. Perianth of same (by Harvey).
8. Perianth of female flower of Harvey's *M. Polemanni*.
9. Another form of female perianth.
10. Female flower of *M. Sollyi* (as drawn by Harvey-Gibson).
11. Bracts of female flower in the fruiting stage.
12-18. Various forms of the margin of the perianth of the female flower.

The question arises, what is to be the name of the species? Ecklon and Zeyher distributed the plant as *Balanophora capensis* before Harvey had published his names, but as the authors did not attach any description to their distribution this name is not valid.

In 1849 Presl (Prague) examined a plant which consisted only of the fruiting part of the spike, and considered the plant to be diœcious. On the strength of his observation he thought it to be generically distinct from *Mystropetalon* and named it *Blepharochlamys capensis*, adopting Zeyher's specific MSS. name. Eichler (*loc. cit.*, 125) surmises that the withered male portion of Presl's plant had fallen off, and thus deceived the author. This need not have been the case, for several good-sized and fully developed specimens in my herbarium are entirely female, the apex being acute, and not rounded and obtuse as in normal plants.

Under the circumstances the species must bear one of Harvey's names, and as *M. Thomii* stands first, we have to adopt this, the other two names becoming synomyms.

As the morphology and anatomy of thallus and shoot have been fully dealt with by Harvey-Gibson, and as a detailed description of leaves and flowers is contained in the preceeding pages, there is no need for giving a full description of the species here, but I take this opportunity to add a few remarks in order to fill up some gaps in former accounts.

Anatomy.–Harvey-Gibson speaks of a peculiar brown granular deposit found in the tissues of all the organs of the plant, and names this substance "mystrin." Having never noticed this substance in the cells on former occasions (fresh material), it occurred to me that this so-called mystrin might have been produced by the preserving fluid (formaldehyde). This surmise was found to be correct, for the contents of the cells of fresh plants (shoot, leaves, bracts) are colourless, and the cell walls yellow or brown. By placing pieces of the plant into dilute formaldehyde, one coagulates the protoplasm of the cells, and this becomes dark brown in course of time. On the other hand, the cells of the fresh plant, as well-dried pieces or pieces preserved in alcohol show numerous starch grains similar to those of wheat, but much smaller and with a large nucleus.

Male Flower.—Colour.—There are nearly always three colours present. The claws are generally yellow, the base of the spoon-shaped blades is carmine, and the blade itself dark claret colour. Occasionally the carmine colour extends to the claws, and such plants look much darker; in other cases the claws are yellow, but the blade itself is carmine, the tip only being darker—such plants appear much brighter.

Pollen.—This is always white and lumpy, the grains cubical, but usually mixed with some pentagonal, or hexagonal, and more rarely also tetrahedral grains.

Female Flower.—Anterior bract. At flowering time always

longer than the other two, in shape narrow-oblong or lanceolate. At the fruiting stage the bracteoles mostly considerably larger than the anterior bract, but in flowers which were not fertilized they may remain shorter or become of equal length only.

Perianth.—This is the most variable part of the flowers. It is either globose or campanulate, or shortly-tubular or tubular and cylindrical—its margin is either quite entire or finely denticulate, or slightly trilobed with the lobes truncate and entire or denticulate, or it is distinctly trifid, the teeth being shortly triangular and entire or bifid, or the lobes are lanceolate-acuminate, or linear, and varying in length, forming one-eighth of the perianth to half or two-thirds; the anterior lobe of the tubular forms is generally a little larger and recurved, while the other two are erect.

Biology.—Flowers with a peculiar scent (not carrion-like), secreting an ample supply of nectar, thereby attracting bees, flies, and sunbirds (Nectarinia).

The fruitlets (pseudonuts) are carried by ants into their underground nests for the sake of the oleiferous receptacle (elaiosome).

Literature.

A nearly complete bibliography is given by Harvey-Gibson on page 153 of his paper. For our purpose it will be sufficient to quote some of these publications and add two others.

1. Harvey, W. H.—On two species of a new South African genus of the order *Rhizantheæ* of Blume.—*Annals of Nat. Hist.,* Vol II, No. 12, Tab. XIX and XX (1839).
2. Harvey, W. H.—" Flora Capensis," Vol. II, 573 (1862).
3. Wright, C. H.—In " Flora Capensis," Vol. V., Sect. II, 214 (1915).
4. Presl, Carolus Bor.—" Epimeliæ Botanicæ," Pragæ, 245-246 (1849).
5. Eichler, A. W.—In De Candolle's "Prodomus," XVII, 125 (1873).
6. Harvey-Gibson, R. J.—Observations on the morphology and anatomy of the genus *Mystropetalon* Harv.—*Trans. Linn. Soc.* VIII, Part 4 (December, 1913).
7. Marloth, R.—The Flora of South Africa, Vol. I, Tab. 40, (1913).

(*Read July* 4, 1917.)

SOME SUITABLE MATERIALS FOR PAPER-MAKING.

By James Leighton, F.R.H.S.

The present is a fitting time to direct our attention to new sources of supply of suitable material for the manufacture of paper. The great scarcity of all kinds of paper is felt, and prices have advanced from 200 per cent. to 600 per cent., according to kinds required.

Many of our indigenous and exotic plants are capable of producing a good quality of paper, but we need to give our attention only to those kinds that are of suitable quality and easily obtainable in quantity.

In the early days of the industry, paper was made from rags, worn-out garments, cuttings and waste from looms. Later it became necessary to find other sources of supply, of which straw, disentegrated wood and the Esparto (or Alfa Grass) of Spain and North Africa are the chief. England uses very largely the Esparto Grass, which grass is not used at all in America, where about 75 per cent. of the pulp used is obtained from wood. The finest grades of paper are still made from flax and cotton, but this amounts only to about 5 per cent. of the total. Plant fibre when pure is a white semi-opaque substance, insoluble in all ordinary solvents and chemically known as cellulose, the formula being $C_6H_{10}O_5$: that is, six equivalents of carbon, ten of hydrogen, and five of oxygen are united together to form the substance known by that name. These proportions are constant, although the physical characteristics may differ widely. Before the cellulose can be made available for the manufacture of paper, it must first be freed from its combination with the non-cellulose constituents with which it is united to form the plant structure. Cotton as well as the filiform silky bracts of the involucre of *Typha* are examples of pure cellulose. We are fortunate in having large supplies of suitable material in the form of Tambookie Grasses capable of making the larger lines of paper in daily use. These grasses have been thoroughly examined by the Imperial Institute and pronounced to be about equal to the well-known Esparto Grass.

I am indebted to Dr. A. Schulz, of Durban, for various samples of wrapping paper made from different species of Tambookie Grasses obtained from various parts of South Africa, but all species having the same characteristics. Bertrams, Limited, of Edinburgh, who have prepared these samples, pronounce them "Excellent," and state that "There is no doubt that this material will produce a reasonably strong paper without the assistance of any stronger materials."

They state, however, that "It must be kept in mind that pulp made from any grass such as Tambookie cannot produce a strong wrapping paper to compare with paper made from hemp or the like." They state that "the fibres in Tambookie are very similar

to those in Esparto, and Esparto will not make what is termed a strong paper, but it does make a paper of a high quality." The samples were all made without the addition of any colouring and show the material colour of the pulp. I believe one of the grasses submitted to Bertrams was *Andropogon hirtus L*, a grass common throughout the country and growing to a height of from two to three feet.

Andropogon nardus L. var. *marginatus*, Hack, a rigid coarse grass, growing in dense tufts to a height of five or six feet, common on patches adjoining the forest and on flat, damp hill-tops and moist places. Stock do not eat this grass, but it is in much demand as a thatch, and if properly used with last 20 years. As its name implies, it is pleasantly scented. The lemon grass of India is a species of *Andropogon*. Mr. Jas. Simpson, of Port Elizabeth, a practical papermaker, has kindly prepared paper from a sample of this grass, which he pronounced to be first of a number of good samples prepared by him. The menu cards used at the last Port Elizabeth Agricultural Show Dinner were made from this grass.

Cyperus textilis (common near rivers and wet localities throughout the country) is capable of producing a very strong paper, and would prove of great value for mixing with grass pulp when an extra strong paper is required.

Another species of *Cyperus*, *C. hexangulare* is probably not inferior to the last-named species as a pulp-producing plant. This species grows in less moist places and more in the open than the *C. textilis*, but it is usually a close neighbour. Like the former species, five or ten per cent. of this fibre will do much to strengthen the grass pulp.

Sansevieria thyrsiflora, a liliaceous plant fairly common as an underbush throughout the Eastern Province, is capable of producing a very fine paper, but it is of more value as a cordage and will be dealt with under that heading. The Plantain produces a fine fibre suitable for the production of a strong paper. The plant can be grown in many places where the less hardy Banana would not thrive.

Fleurya peduncularis, a precumbent Nettle common in moist places, makes a fine paper, but it is not found in great quantities.

Agave americana has been introduced all over the country, and there are large quantities now ready for use for producing paper pulp. Mealie cob husks are of increasing value for paper-making, and the centre of the cobs from which the mealies have been separated, is used for the manufacture of celluloid and as a material from which a kind of linoleum is prepared.

With so much valuable material at hand it should not be difficult to supply a mill with pulp for the production of wrapping papers and a bleached paper for newspapers.

Some suitable centre should be selected near the source of supply, where pure water is plentiful and, if sufficient for motive

power it would be desirable, otherwise the mill should be erected where fuel is plentiful at some convenient centre.

In India a superior chemical paper made from local raw material has, owing to its cheapness, ousted the foreign inferior article out of the market. With the abundant supply of excellent material at its disposal, South Africa should not stand behind India in this respect, but should retain at least half of the large sum of over £400,000 annually spent in the import of paper into the Union.

The *Andropogon nardus* will produce close on 50 per cent. of pulp. Pulp requires the addition of about 10 per cent. of extra stuff, clay, size, etc., to make it into paper.

I have dealt with but a few of the species of grasses and other plants which might be utilized for the purpose of paper production, but doubtless these are many other plants that will prove of value for this purpose, especially among the Monocotyledons, and with such a plentiful supply of raw material it remains to be seen whether South Africa will utilize its resources and supply an industry which would be beneficial to commerce as well as a valuable asset to the country.

Read, July 3, 1917.)

Potash from Kelp in America.—It is stated that kelp is now being harvested by one concern near San Diego in California in quantity sufficient to supply three times the amount of potash annually imported from Germany before the war. A second plant of equal capacity has been established in the same vicinity, and a smaller plant has also been installed by the Government. Every working day 1,500 tons of cut kelp are conveyed by ship to a crushing mill. A sticky, gelatinous mass results, containing about 80 per cent. of water, and can be pumped through a six-inch pipe to barges and thence to digestive tanks, of 50,000 capacity each. The material is subsequently put through processes of evaporation.

Fixation of Atmospheric Nitrogen in New Zealand.—The *Journal of the Royal Society of Arts* (65, 783), states that at the instance of the National Efficiency Board, New Zealand Government, a project for preparing nitrates from the air by the agency of some of the large falls in the south-western sounds of New Zealand is under consideration. One of the simplest propositions is the utilisation of the Bowen Falls, from which, it is estimated, energy could be produced at the rate of one-fiftieth of a penny per unit. The Chief Electrical Engineer to the New Zealand Post and Telegraph Department doubts whether there is a more favoured spot in the world than Bowen Falls, and considers that nowhere in Germany, Norway and Italy can electricity be generated more cheaply.

THE PROPOSALS FOR A LEAGUE OF PEACE—BRITISH AND AMERICAN.

By Rev. RAMSDEN BALMFORTH.

(*Abstract.*)

There is a considerable body of thoughtful opinion in every country which is looking forward to some form of international organization for the settlement of disputes between nations by peaceful means. Indeed, if the present war does not issue in some such organization, the immense sacrifices which have been made during the last three years will have been made largely in vain, and we, or rather humanity, will have suffered virtual defeat. Before the war, this idea of the pacific settlement of disputes by an appeal to the best reason and judgment of the world had taken deep root in the minds of far-seeing statesmen like Mr. Gladstone; and, since the war began, Mr. Asquith, Sir Edward Grey, Mr. Balfour, President Wilson, Chancellor Bethmann-Hollweg, and eminent Russian and French statesmen have explicitly declared themselves in favour of it. The Allies, in their reply to President Wilson's Note, in January, 1917, declare "that they associate themselves whole-heartedly with the plan of creating a League of Nations to ensure peace and justice throughout the world." The idea, therefore, is not utopian. Its realisation has come within the range of practical politics. As a result of this growing body of opinion two societies have been formed: one in the United States, called "The League to Enforce Peace"; the other in Great Britain, called "The League of Nations Society." The programme of the American Society is as follows:—

"We believe it to be desirable for the United States to join a League of Nations binding the signatories to the following:

"*First*: All justiciable questions arising between the signatory powers, not settled by negotiation, shall, subject to the limitations of treaties, be submitted to a judicial tribunal for hearing and judgment, both upon the merits and upon any issue as to its jurisdiction of the question. .

"*Second*: All other questions arising between the signatories and not settled by negotiation shall be submitted to a council of conciliation for hearing, consideration, and recommendation.

"*Third*: The signatory powers shall jointly use forthwith both their economic and military forces against any one of their number that goes to war, or commits acts of hostility, against another of the signatories before any question arising shall be submitted as provided in the foregoing.

"*Fourth*: Conferences between the signatory powers shall be held from time to time to formulate and codify rules of inter-

national law, which, unless some signatory shall signify its dissent within a stated period, shall thereafter govern in the decisions of the Judicial Tribunal mentioned in Article I."

The programme of the English Society is very similar to this, with one important difference, which is this: The American League proposes only to use armed force against any one of the signatory Powers, if such Power goes to war *before* the question in dispute shall have been submitted to the Judicial Tribunal or to a Council of Conciliation. It does not contemplate or authorize the use of force in order to compel the acceptance or observance of the judgment of the Tribunal or the Council. There may be good reasons for this. I have never heard of the judgment of an International Arbitration Court being flouted, and it may be thought by the promoters of the League that the reasoned judgment of the highest Judicial Tribunal in the world, registering, as it were, the judgment of mankind, will carry such overwhelming weight and authority as to ensure observance. The British Society, however, goes a step further. It binds the signatory Powers to accept, and, if necessary, enforce, the judgments of the Judicial Tribunal, but not the awards of the Council of Inquiry and Conciliation.

It is necessary, therefore, to bear clearly in mind the difference between the Judicial Tribunal and the Council of Enquiry and Conciliation, and the different sorts of cases which would be referred to them. The former would deal with what are termed justiciable disputes—that is, disputes which arise out of divergent interpretations of International Law or of the various treaties made between nations. The latter would deal with what are termed non-justiciable questions—that is, questions not covered by treaties or by International Law; such questions, for example, as the exclusion of Japanese or Chinese immigrants from Australia or America. Such questions are, of course, much more inflammable than justiciable questions, and it is just these which would test most severely the influence and authority of a League of Peace.

It should be emphasized that the pressure which might be exercised by the League on any recalcitrant nation which refused to abide by the decisions of the Judicial Tribunal need not necessarily take the shape of armed force. The prohibition of postal and telegraphic communication; the prohibition of banking and stock exchange transactions in connection with such State; the prohibition of certain specified imports to, or exports from, the recalcitrant State; the laying of an embargo on all ships within the jurisdiction of such State; the payment of all debts due to the citizens or to the Government of such State to some duly constituted International Bureau until such time as a settlement had been arrived at—these and many other measures might be taken, and so render armed intervention unnecessary. But such intervention is an emergency which would have to be provided for and would take the form of an International Police force, acting, of course, not in the interests of any

one nation, but in the interests of the whole of the League, and virtually, presumably, of the whole world.

The advantages of such a League would be: first, that ample time would be given for investigation, consideration, and discussion in any dispute that might arise. We should not be rushed into war as Europe was rushed in 1914. Second, both the larger and the smaller nations of the world would have a greater feeling of security than they have ever enjoyed before. Third, the League would probably develop into a body for the peaceful revision of treaties and the better development of International Law, thus providing the means for growth, change, and development, without which permanent peace is impossible. Fourth, as the feeling of mutual trust spread, and fear was undermined and destroyed, there would be an immense reduction in the expenditure on armaments. Fifth, and perhaps most important of all, such a League would define once and for all the meaning of the term "aggression." At present, in every war, each belligerent always charges the other with being the aggressor, and every belligerent government publishes Blue books to prove that it is innocent of the horrid deed. Once get this League of Peace in being, and the aggressor is defined once and for ever—it would be the Power which refuses to put its disputes to the judgment of the appointed representatives of the collective reason of the world—*i.e.,* to a World Court specially appointed for the impartial consideration of such disputes.

These proposals to establish a League of Peace have been criticized and attacked by two sets of extremists—the extreme militarists and the extreme pacifists. The extreme militarists criticize them from the standpoint of State power and State morality, and a rather crude and superficial interpretation of the theory of the survival of the fittest applied to nations and peoples—an interpretation which Darwin, Spencer, Huxley, and most of the great evolutionists would repudiate. Humanity is at a turning-point. We stand at the crossroads between the old Machiavellian State-craft, with its theory of State-power, and a new order, with new forms of world-government based on "the paramount of authority of right reason." That is the alternative. It means either a descent into what is worse than brute savagery, with all the forces of science and intellect harnessed to that end, or an advance towards those forms of organization which will make for survival towards a higher type of life.

The extreme pacifists criticize the proposed League of Peace on the religious ground that all war and all preparation for war is wrong. Those who hold this view—Buddha, St. Francis, George Fox, Tolstoi, and many others—are among the salt of the earth, and their attitude of mind should not only be respected but encouraged, for the more people there are in every nation who have religious objections to war, the less likely are we to have war. No system of ethics can justify the negation of morality, the mass judgments, the brute methods of controversy, and the sacrifice of the innocent for the misdeeds of

the guilty which war involves. The League of Peace would be a step on the road to the abolition of these things by substituting reason and law for brute force. Compulsory militarism and compulsory schemes of defence must always split on the rock of religious or conscientious objection to the military oath and its meaning. Even despotic Russia dare not suppress Tolstoi.

The smaller nations of the world would have a direct interest in promoting and supporting such a League, and though they may not have a voice in framing the terms of peace, that is no reason why they should not have a voice in the framing of the terms which will make peace more secure in the future. After the Crimean War, and also after the Russo-Turkish War, non-belligerents as well as belligerents were admitted to the Peace Conference, and there is no reason why the same course should not be followed at the close of the present war, especially on those points which concern the safety of all nations from aggression, and the creation of the machinery and the organization necessary for securing the observance of the common will.

Four important considerations emerge from this discussion. First, that the proposed League must not be a static body prescribing a rigid and inelastic scheme. It must provide for the development of nations, otherwise it will make the same fatal mistake as that made by the Holy Alliance. It is probable that it will develop into an International Council for the revision of treaties, the development of International Law, and for the discussion of such questions as affect the relations of States and peoples to each other, and the obstacles which stand in the way of the natural and legitimate expansion of peoples. There is a strong tendency towards Internationalism everywhere, as is shown by the fact that while, in 1874, there were only 54 international organizations in existence, in 1914 there were 494.

Second, the formation of the League will probably lead to a reduction and limitation of armaments, which have become a crushing burden everywhere. Such limitation, in proportion to population and territory, will probably become an arbitrable issue.

Third, the question has been raised as to whether Germany should be admitted as a member of such a League. It is a significant fact that the founders of both the American and British societies declare themselves strongly against the exclusion of Germany. Her exclusion would mean two rival Leagues, with endless intrigues and rivalries everywhere—the discredited Balance of power over again. In looking towards the future we have to separate the German people from the German militarists. We must look both for a renovated Germany and a renovated Europe.

Fourth, what effect is the proposed League of Peace likely to have on the relation of native and uncivilized peoples to the civilized nations of the world? That question is of special interest to us in South Africa, for we have not only our own

native peoples to consider, but those vast aggregations of uncivilized natives in Central, West, and East Africa. I believe that a League of Peace would have a very decided influence for good in this matter, for it would set itself, by means of special commissions, to work out what I may call a code of International Law or justice which might be applied throughout the length and breadth of European-controlled Africa. Every student of native policy knows that neither the individual pioneer nor the pioneer commercial Company is to be trusted to deal out justice to aboriginal natives. The early history of America, of Australia, of South Africa, and recent revelations in Putamayo, the Congo, and German South-West Africa, afford overwhelming evidence of this. Hence it is of vital importance to us that we should have a uniform European or International code of justice on which the natives of Africa might rely and to which they could appeal. It is essential that we should get the educated native throughout the whole of Euro-Africa on our side, and we can only do this by making the standard of justice uniform, by making it high, and by welcoming, as far as possible, the educated native into Advisory Councils. From this it would not be a long step to a Euro-African inter-State Council and arbitral Court of Appeal. If South, East, West, and Central Africa are not to follow the terrible example of Europe, it is essential that we win the confidence of the native races, and that the missionary, the teacher, and the magistrate should be the advance guard, not of the bayonet, the bomb, and the whiskey barrel, but of the spirit as well as of the precepts of the New Testament and the Golden Rule. In this connection, I might remind you that International Conferences have already done much to remove the horrors of the African slave trade, and to ameliorate the treatment of native races in the various parts of Africa which are controlled by European Governments.

We have seen, then, that the germ of the idea behind the League of Peace is already in being. Not only that—it is at work. Already, some 20 treaties, embodying the second article of the proposed League, that is, that all disputed questions not settled by negotiation shall be submitted to a Council of Inquiry and Conciliation for hearing, consideration, and recommendation, are in force. They have been signed since the beginning of the present war. The next step is a Permanent International Council, with adequate sanctions for maintaining peace, and with the necessary deliberative bodies through which the public opinion of the various nations of the world can find expression on moot questions of national expansion and development as they affect this or that section of mankind. I do not conceal from myself the baffling complexity and intricacy of the task which lies before the statesmen of the world—of the national, racial, religious, political, military, economic, and commercial problems which are involved. To some people they will appear so baffling that they will throw up their hands in despair. But I would remind you, not only of the frightful alternative, but of the responsibility which

lies upon each one of us at this hour. For it does seem to me that any man who, by voice or act, would endanger even an attempt to appeal to the reason of the world, and who would thereby help to continue the monstrous agonies and cruelties of the present order—such a man, I say, hardly seems to me to realize his responsibilities as a human being. Either civilization must make an end of war, or war will make an end of our civilization, and a new race will arise, with stronger brains and larger hearts, to carry forward the higher development of humanity.

(*Finally received, August* 3, 1917.)

Distances of the Dark Nebulæ.—R. F. Sanford, in *Lick Observatory Bulletin* No. 297, discusses some relations of the spiral nebulæ to the Milky Way. Amongst these relations is the distribution of spiral nebulæ in space. That dark nebulæ exist is evident from the occurrence of "Coal Sacks" and other dark "holes"—patches devoid of stars in the very densest parts of the Milky Way. It may be assumed that the apparent density of the Milky Way structure is a function of the depth from which the stars of the galaxy are sending their light, hence the region of the northern Coal Sack is one in which the system of light-giving stars is comparatively near to us, and it follows that the obstructing matter, coal sack, or dark nebula, must be nearer still, and lies well inside the galactic structure. The Milky Way, moreover, is not a regular cloud belt across the sky, but is intersected by a very network of dark, irregular lanes. It is evident that to some extent at least this network consists of obstructing matter analogous in character to the dark nebulæ.

TRANSACTIONS OF SOCIETIES.

Royal Society of South Africa.—Wednesday, August 15th: Prof. L. Crawford, M.A., D.Sc., F.R.S.E., in the chair.—"*Note on the resolvability of the minors of a compound determinant*": Sir Thomas **Muir**.—"*The Spectra of the Mixed Phthaleins and of the Sulphone-phthaleins*": Dr. J. **Moir.** The spectra of 18 mixed phthaleins, containing two different phenol residues, were described, and the laws governing the colour elucidated. The method is an excellent analytical one for identifying phenols and amines and their ethers and derivatives. The spectra of five sulphone-phthaleins made from saccharin were also described, as well as six more new derivatives of ordinary phenolphthalein. A new general formula for the coloured substances was put forward.—"*Kimberley Diamonds: especially Cleavage Diamonds*": Dr. J. R. **Sutton.** A general and statistical account of the diamonds produced in the mines under the control of the De Beers Company at Kimberley. The outstanding differences in size, colour, and type, between the yields of the different mines were described. The author advanced a view that many diamonds have been naturally broken by the unequal expansion of themselves and mineral inclusions. It appears that brown diamonds have shown a particular disposition to come up broken from the deeper levels of the Wesselton mine, but the author doubts the common assertion that brown or smoky diamonds are markedly

liable to spontaneous fracture.—"*On the Phanerogamic Flora of the Divisions of Uitenhage and Port Elizabeth*": Prof. S. **Schonland.** There are 2,290 species recorded, of which 98 are considered by the author not to be native. They are distributed over 128 natural orders and 712 genera. There are, however, still large tracts of this area unexplored. Most of the localities quoted are contained in about 600 square miles, while the total area is about 2,500 square miles; much of the remaining tract is, however, covered by fairly uniform karroid succulent vegetation.—"*A Lunar Period in the Rates of Evaporation and Rainfall.* Dr. J. R. **Sutton.** The author called attention to the possibility of a lunar influence governing the evaporation from a water surface, and a lunar period in the incidence of rainfall. As a result of hourly observations of evaporation and rainfall during the 120 lunar months from August, 1899, to April, 1909, rainfall has its maximum frequency about the time of moonrise, and its minimum just after moonset; the rate of evaporation has a maximum and minimum, respectively, shortly after the moon passes the meridian above and below the horizon.

Wednesday, September 26th: L. A. Péringuey, D.Sc., F.E.S., F.Z.S., President, in the chair.—"*Note on the Abnormal Development of the Genital Organs of* Jasus Lalandii." W. **von Bonde.** The author recorded a peculiar abnormality in a male Cape Crawfish. Three distinct genital apertures were developed, two normally, and a third abnormally, the latter occurring on the fourth walking leg of the right side.—"*On the Colour-Octahedron as a Complexity: being suggestions towards a mathematics of Colour*": Dr. G H. **Malan.** Developing certain ideas of Meinong, who contends that the possibility of representing certain well-known facts in connection with colour-psychology by a diagram in the form of an octahedron rests on the presence of certain *a priori* relations incidental to the very nature of colour itself, the author examined Meinong's contention critically in the light of modern mathematical logic. Meinong's theory, though true in its intention, is seriously at fault in its practical conception of an *a priori* science of colour, because of the ignorance of its author of the principles of mathematics as revealed by recent researches of mathematicians. A more exact discrimination between the standpoints of empirical psychology and mathematical science is necessitated.—"*A List of South African Fungi*": Miss A. M. **Bottomley**. A systematic compilation, with indexes of all the South African fungi in the Government Mycological Herbarium. 276 genera and 800 named species were recorded.

Wednesday, October 17th: A. J. Anderson, M.A., M.B., D.P.H., M.R.C.S., Vice-President, in the chair.—"*Spectrum phenomena in the Chromium Compounds*": Dr. J. **Moir.** It has been found that although aqueous solutions of the chromium salts do not show any narrow characteristic bands in the spectrum, yet when anhydrous (or nearly anhydrous) solutions are used, the spectrum is crossed by narrow bands in the red similar to what are seen in the ruby or emerald spectrum. The solutions of chromium oxide in concentrated sulphuric and in fused metaphosphoric acid have been investigated and the bands measured; they are very similar to those seen in the emerald, but not absolutely identical; whilst the bands of the ruby, although similar in arrangement, are displaced into a region of lower frequency. Both gem colours are due to chromium, but the vibrations are differently loaded (silica and beryllia against alumina).—"*Derivatives of the unknown ortho-para-phenolphthalein.*"—Dr. J. **Moir.** Phthaleins in which one of the hydroxyl-groups is *ortho-* and the other *para-* to the central carbon have been prepared from para-substituted phenols with oxybenzoylbenzoic acid. They are like the common phthaleins, but their absorption-bands are broad, although in much the same position. An attempt to make *o-p*-phenolphthalein itself gave a product very closely resembling common phenolphthalein, and a similar substance was obtained by dehydrating oxybenzoylbenzoic acid alone with sulphuric acid. They are, nevertheless, probably not identical with common phenolphthalein. "Phenolphthaleinoxime" is not an oxime, but is the *p*-oxyanil of oxybenzophenonecarboxylic acid. Common phenolphthalein in normal alkali is colourless when cold, but becomes pink on warming.

PARASITIC PROTOZOA IN RELATION TO THE WAR.

By H. B. Fantham, M.A., D.Sc., F.Z.S.,
Professor of Zoology, University College, Johannesburg.

(*With 23 Text-figures.*)

Filth, famine, and disease follow in the wake of war. These three inimical agencies in previous wars have, proportionately, taken heavier tolls of life than in the present war, owing both to the measures taken to ensure greater general cleanliness, to preventive inoculation, and to the great strides in the exact diagnosis of many maladies that previously were confused, the result being more appropriate and rapid treatment.

Wherever large bodies of men are massed together on ground that has been or is being fought over, unsanitary conditions arise. These conditions may be due to the inevitable paucity or lack of conveniences for cleanliness, or may result from the action of the guns in turning up old graveyards, cesspits and the like, and by forming craters, some deep, some shallow, wherein the breeding of insects transmitting certain diseases can go on almost without limitation. Many of the epidemic diseases that may arise among the military forces can be roughly classified as intestinal and blood maladies, and the actual causal agents are mostly minute, bacteria and protozoa being among the chief.

Intestinal ailments have been prevalent in certain war zones, especially those in or near the tropics. Preventive inoculations against typhoid, paratyphoid A, paratyphoid B, and cholera have had marked success in reducing the number of cases of such diseases almost to a minimum. The various dysenteries and diarrhœas, however, have caused much trouble. Some of these maladies have been due to the Shiga and Flexner bacilli. Others have been caused by Protozoa, including *Entamœba, histolytica*, the agent of amœbic dysentery; various flagellate Protozoa, such as *Giardia (Lamblia) intestinalis, Chilomastix (Tetramitus) mesnili, Trichomonas hominis, Cercomonas hominis*, and *C. parva;* sporozoan parasites, such as *Isospora bigemina* and *Eimeria stiedæ;* and Ciliata, such as *Balantidium coli.*

The protozoal parasites of the blood include the causal agents of human malaria and relapsing fever, as well as trypanosomes that produce sleeping sickness in man and nagana in animals.

As this paper was read before a joint meeting of all the sections of the Association, the various technical terms are reduced to a minimum, and brief explanations are given of most of those used.

Intestinal Protozoa.

During the war, I have personally examined many thousands of diarrhœic and dysenteric stools from soldiers who contracted disease in Egypt, Gallipoli, Salonika, Mesopotamia, West Africa, East Africa, and Flanders. In the dysenteries of protozoal origin,

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one or more of the parasites named as occurring in the intestine were present, there being both single and multiple infections, while there was a periodicity in the appearance of the different parasites in the successive stools of the same patient.

Some of these intestinal Protozoa may now be briefly considered :—

Intestinal Entamœbae.

The best known of the protozoal dysenteries is that due to *Entamœba histolytica*. This organism, which is polymorphic, is the excitant of amœbic dysentery. Its life-history, as now accepted, has been elucidated more particularly by Darling, and by James and Deeks in the Panama Canal Zone, while its successful treatment by emetine has been brought forward chiefly by Rogers and by Vedder.

Entamœba histolytica, sometimes called with doubtful accuracy *Endamœba dysenteriæ*, is found in freshly voided stools that are usually blood-stained and contain strings of mucus. The enta-

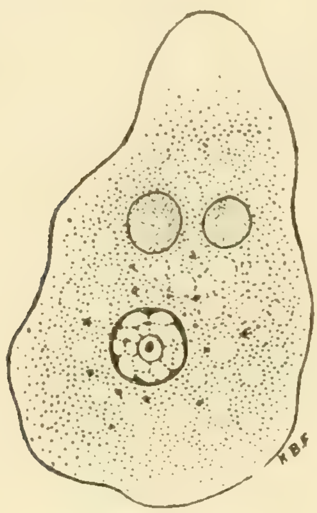

Fig. 1.

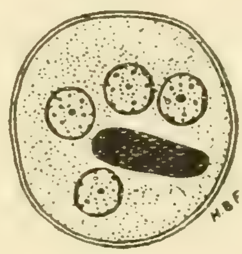

Fig. 2.

mœbæ when active show pseudopodia, at first chiefly composed of ectoplasm. The endoplasm often contains ingested red blood-corpuscles and other débris. The nucleus in large trophozoites (or growing, feeding amœbæ) may be seen with difficulty, but in the form of the organism that used to be termed *E. tetragena* the nucleus may show a karyosome and a centriole (Fig. 1). The entamœba multiplies by binary fission, and occasionally by multiple fission or schizogony, when four merozoites or daughter forms are produced. Encystment occurs, and the round cysts finally produced measure about 10μ* to 15μ in diameter, though strains with small cysts about 7μ to 10μ in diameter are known. The mature cysts contain four nuclei, as well as darkly staining masses variously known as chromidial, chromatoid, crystalloidal, or siderophile bodies (Fig. 2). The quadri-nucleate cyst is characteristic, and is the infective stage. When the cyst is hardly mature

* $1\ \mu$ denotes 1 micron, or $\frac{1}{1000}$ millimetre.

and has only one nucleus, that structure is relatively large, being as much as 5μ in diamater.

In cases of relapse, or those that have remained without treatment for a long time, a generation of smaller trophozoites is associated with or replaces the larger ones, and these small parasites tend to lie on or near the surface of the intestinal mucosa. The smaller forms are the senile or pre-cyst generation of Darling. The small entamœbæ were described separately by Elmassian in 1909 as *Entamœba minuta*, the parasites being obtained from a case of chronic dysentery in Paraguay. It is interesting to remark that in subacute cases of amœbic dysentery, with much mucus in the stools, but not much blood, the parasites seen are of the type formerly described separately as *Entamœba tetragena*.

A patient showing acute symptoms of dysentery is not necessarily infective to others, for he is often merely harbouring the large trophozoites of *E. histolytica*, which, by animal experiments, have been shown usually to be non-infective when fed by the mouth. The stools of convalescent and recovered patients may still contain cysts, and so such persons may act as carriers of the disease. Natives in tropical countries may act as carriers. *Entamœba histolytica* is transmitted from man to man in the encysted condition. Food and water contaminated with infected excrement are common sources of infection, and dust contaminated with fæcal material may be infective. It has also been proved that various flies can transfer the cysts of *E. histolytica* from place to place. Flies feed on infected human excrement, and then visit fruit, vegetables, milk, etc., intended for human consumption. The cysts of the entamœba pass unharmed through the alimentary canals of the insects and pass out with their excrement on to the surface of human food, which is a source of infection to persons partaking thereof.

It may be mentioned that rats can serve as reservoirs of amœbic dysentery, as well as the human carriers already mentioned.

Ulcers due to *Entamœba histolytica* occur in the large intestine. The entamœbæ may invade the liver, producing abscesses in that organ. The subcutaneous injection of 10 to 12 grains of emetine, in daily doses of 1 grain, will usually be found efficacious in amœobic dysentery, though the *minuta* form of the parasite may be relatively resistant thereto. Emetine bismuthous iodide by the mouth, in doses of 3 grains per day for 12 days, has also given good results, as well as emetine hydrochloride by the mouth.

The dysentery-producing entamœbæ must be distinguished from *Entamœba coli*, a parasite which may be found in the alimentary tracts of healthy persons. *E. coli* divides by binary fission or sometimes by schizogony into eight daughter forms. The cysts contain eight nuclei when mature (Fig. 3). They measure about 15μ to 20μ in diameter, and may reach up to 30μ, and so are slightly larger than those of *E. histolytica*. The

cyst wall of *E. coli* is often thicker than that of *E. histolytica*. Chromidial or chromatoid blocks are seldom present in the cysts of *E. coli*, but if present, they frequently have pointed ends. Red blood-corpuscles are rarely, if ever, ingested by the trophozoites of *E. coli*.

It has recently been claimed that another non-pathogenic species, *E. nana*, may occur in the human intestine. Its trophozoite is small and vacuolated, containing ingested bacteria, and it has a distinctive nuclear structure. Its cysts when mature are usually quadrinucleate, being oval or sometimes spherical, and measuring 8μ to 10μ by 7μ to 8μ. Chromatoid bodies are said to be absent from the cysts.

Free-living amœbæ of the *limax* group may also be found occasionally in human stools.

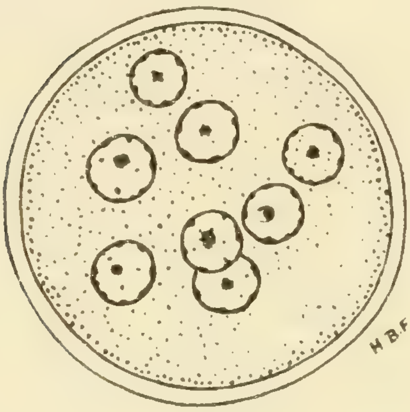

Fig. 3.

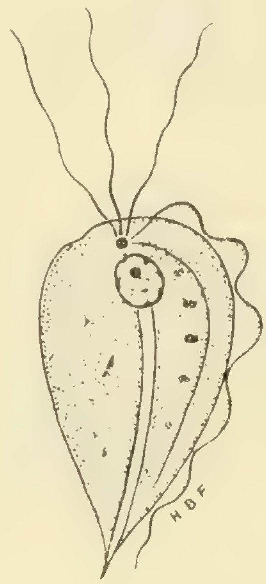

Fig. 4.

Intestinal Flagellates.

The Mastigophora found in stools have already been mentioned, and may now be briefly described.

Trichomonas hominis or *T. intestinalis*, as found in the human intestine is pear-shaped, with three free flagella at the blunt or anterior end. There is also a lateral flagellum attached to the body by an undulating membrane, and an axial rod running towards the pointed end of the body from near the anteriorly placed nucleus (Fig. 4). The flagellate measures about 10μ to 15μ by 5μ to 10μ. Rounded contracted forms may be found in the fæces. Similar trichomonads occur in rodents, such as rats, mice, and rabbits, and also in cats. Possibly rats and mice act as reservoirs of the parasites. Trichomonads may also be water borne. Mello Leitao (1913) found *T. hominis* in cases of relatively benign dysentery in Rio de Janeiro. Escomel (1913) found 152 cases of dysentery in Peru solely due to trichomonads. *Trichomonas* was found by Fantham and Porter in some patients from Gallipoli, while in certain cases at Suez this flagellate was the cause of diarrhœa. With regard to treatment, the use of tur-

pentine, thymol and calomel, methylene blue, and iodine enemata have been recommended. Prophylaxis is directed to the prevention of contamination of food or water supplies by infected material, by possible insect carriers and by rodents, and to the isolation of human parasite carriers. Allied forms, referred to the genera *Tetra-* and *Penta-trichomonas*, may also occur in stools.

Chilomastix (*Tetramitus*) *mesnili* is pear-shaped and is allied to *Trichomonas*, but it possesses a large cytostome, or cell-mouth, hence its former name of *Macrostoma mesnili*. Three anterior flagella are present, and a fourth one (perhaps attached to an undulating membrane) vibrates in the cytostome (Fig. 5). An axial rod or axostyle is absent. The parasite may measure 14μ by 7μ. Encystment occurs with the production of oval and lemon-shaped cysts, 7μ to 10μ long. (Figs. 6, 7). Tetramitus was found in cases of diarrhœa among patients from Salonika, Gallipoli, and

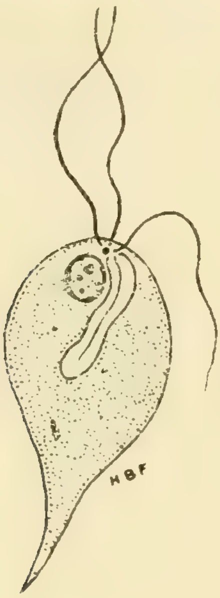

Fig. 5.

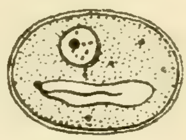

Fig. 6.

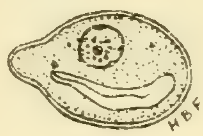

Fig. 7.

Egypt, especially from the first-named area. It has also been found by Fantham and Porter in patients from German East Africa. Pure infections have been seen, and mixed infections of *Chilomastix* and *Trichomonas* have occurred in cases of persistent diarrhœa. As regards treatment, iodine irrigations have been tried, but *Chilomastix* is not easily eliminated.

Giardia (*Lamblia*) *intestinalis* exhibits bilateral symmetry. Eight flagella, arranged in four pairs, are present. The axostyle may be double, and two karyosomatic nuclei occur. A concave sucking disc or cytostome is found on the under surface of the parasite, and serves to attach it to the epithelial cells of the duodenum or other part of the small intestine. Two parabasal granules, situated usually about the middle of the axostyle, are noticed (Fig. 8). The organism is from 10μ to 21μ long, and 5μ to 12μ broad. Multiplication by binary longitudinal and by multiple fission occurs. Resistant cysts are produced. These contain four

nuclei, the remains of the axostyle and the parabasal bodies. (Fig. 9). The cysts serve to spread the parasite. *Giardia* was found by Fantham and Porter to be very common in cases from Gallipoli, 471 stools out of 3,800 examined by them in three months containing this protozoön, while on 137 occasions it was the only protozoön present. The stools were sometimes of peculiar colours and consistencies, were often bulky and diarrhœic in character, and contained mucus. By enumerative methods it was found that there was a greater uniformity of distribution of cysts in a diarrhœic stool than in a semi-solid or formed one. The number of encysted parasites in a bulky stool was calculated by Porter to be 14,400,000,000, the bulk of the stool being 950 c.c. In a stool of average volume, the number was 324,000,000, the bulk being 150 c.c., while in a small stool of 50 c.c. bulk, 10,000,000 were

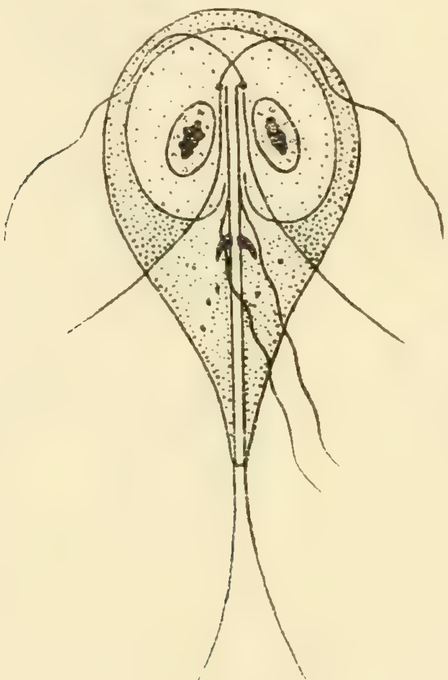

Fig. 8.

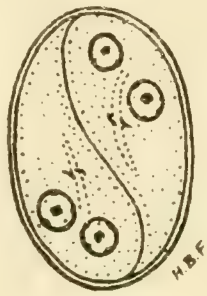

Fig. 9.

found. As each cyst, produced from a suctorial flagellate form, is resistant, efforts should be made to attack the flagellate form, which is probably most numerous in the small intestine when cysts are few in the fæces. The periodicity in the appearance of the maximum crops of cysts varies slightly in different cases, the period being about a fortnight in some and a little less in others. There is a variation from day to day in the numbers of parasites seen in the stools.

It has been shown experimentally by Fantham and Porter that *Giardia* of human origin is pathogenic to kittens and to mice. Parasite-free animals, fed with contaminated food, became emaciated, suffered from either persistent or recurrent diarrhœa, and in most cases died. Erosion of the intestinal cells by the *Giardia* occurred, and blood and shed epithelial cells were found in the

fæces. Sections of the intestine showed epithelial erosion and ulcerative conditions. Similar appearances were found in human intestines examined *post mortem*. Rats, mice, and cats can act as reservoirs of the disease. By contaminating the food or drink of man with their excrement, they may propagate lambliasis. Mathis and others have found lambliasis among patients whose homes were infested with rodents. Healthy human carriers are also known. Bismuth salicylate was found effective in reducing the number of parasites, the cysts disappearing in some cases. The virulence of different strains of *Giardia* varies, and the cysts can remain infective for at least three months.

Prowazekia have been seen in human stools in various parts of the world. Several species have been differentiated, but on slight differences which are really only variations. The flagellates have an anterior flagellum and a lateral trailing flagellum. There is a large blepharoplast internally, near the anterior end, in the neighbourhood of a slight depression or cytostome.

Cercomonas hominis and *C. parva* occurred in some of the dysenteric stools examined by me. They were not very common

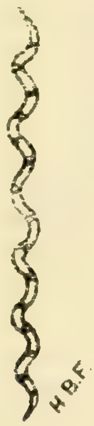

Fig. 10.

The parasites each had one flagellum anteriorly, and another flagellum passed posteriorly over the body; their nucleus was distinct and their movements were active.

The complete elimination of the above-mentioned intestinal flagellates from the body appears to be difficult, and the treatments briefly mentioned have not been particularly successful.

Intestinal Spirochætes.

Spirochæta eurygyrata occurred in the stools of various patients, many of whom suffered from intestinal disturbances. Much morphological variation due to growth and division was found. *Spirochæta eurygyrata* has tapering ends, measures up to 15μ long, and is about 0.25μ broad. It contains a diffuse nucleus, consisting of chromatinic granules (Fig. 10.) The number of coils or waves is variable, depending on the rate of movement and thickness of the organism. The formation of coccoid bodies was seen. The number of spirochætes in a stool varies from day to

day. The more fluid the stool the greater was the number of parasites in my experience.

Intestinal Sporozoa.

Two genera of intestinal Coccidia have been found to occur among military patients. The organisms are *Isospora bigemina* (var. *hominis*) and *Eimeria stiedæ*, and the former was the more common. Most of the patients became infected with the parasites in Salonika, Egypt, or Gallipoli.

Isospora bigemina is a parasite of cats and dogs, and in these animals the jejunum and ileum are most frequently infected. In cases where I experimentally infected clean kittens with *Isospora* of human origin, the jejunum and ileum showed most inflammation, the condition resembling that in man. Both schizogony (asexual multiplication) and gametogony (production of sexual forms) occur in the intestinal epithelium, and the submucosa may become involved. The oöcysts are oval and relatively frail in appearance. They vary from 23μ to 33μ long by 11μ to 15μ broad in human fæces. Each oöcyst produces two sporoblasts, each of which slowly gives rise to four sporozoites (Fig.

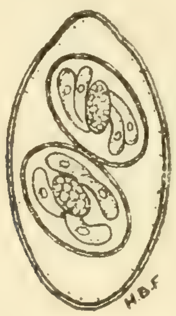

Fig. 11.

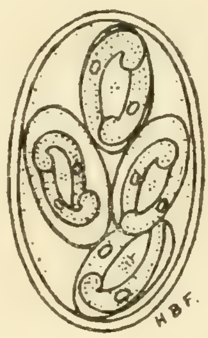

Fig. 12.

11), a large residual mass being present in each sporocyst. Kittens may act as reservoirs of *Isospora*. Oöcysts found naturally in cats may be larger and somewhat thicker walled than those in man, the human parasite perhaps being a distinct species or at least a new variety, for which the name *hominis* is proposed.

Eimeria stiedæ, sometimes still referred to under its old name of *Coccidium oviforme*, is normally a parasite of the duodenum of rabbits and hares. As it also infects the livers of these animals and forms oöcysts there, the eating of imperfectly cooked rabbit livers may be one source of infection. Green foodstuffs contaminated by rabbit excrement are also infective. The oöcysts are oval, varying in length from 24μ to 49μ, and in breadth from 12μ to 28μ. Each oöcyst produces four oval sporoblasts which become sporocysts, and each sporocyst gives rise to two sporozoites (Fig. 12). The oöcysts and spores serve for the infection of new hosts. This parasite was not often seen in the Eastern war zones.

Coccidiosis in birds has been successfully treated by Fantham with catechu, and this drug might be tried in cases of human intestinal coccidiosis. Emetine may possibly be of service.

Intestinal Ciliates.

Balantidium coli is the chief causal agent of ciliate dysentery The parasite is relatively large, with an oval body, 60μ to 100μ (or even 200μ) long by 50μ to 70μ broad. There is a funnel-shaped cytostome or cell-mouth at one pole (Fig. 13). The

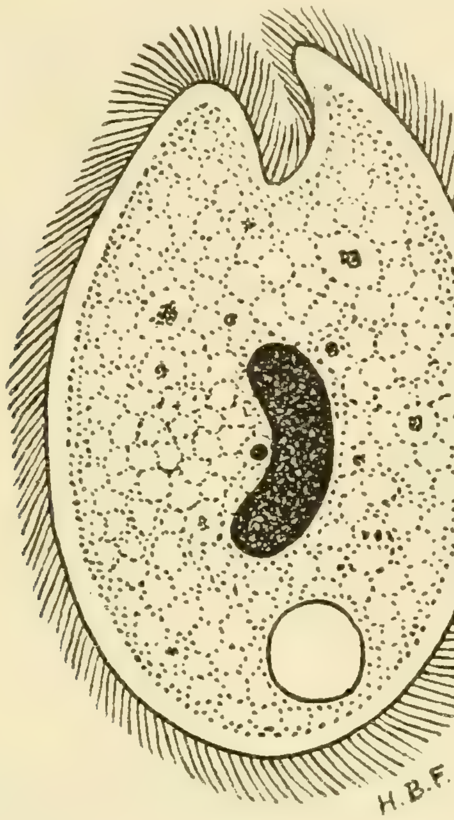

Fig. 13.

organism has a macronucleus, a micronucleus, and two contractile vacuoles. A cytopyge or cell-anus is also present. Occasionally ingested red blood-corpuscles are found in the endoplasm. The parasites form round cysts.

A smaller species, *Balantidium minutum,* is also known. These parasites were occasionally found last year (1916) on the Macedonian front.

Balantidia occur in the large intestine of man, and in the rectum of the domestic pig. The parasites are able to penetrate the intestinal walls of man and give rise to ulcers, though these are rare in pigs. Epidemics have also been recorded in monkeys.

Cases of balantidiasis occur in various parts of the world, especially among swineherds, farm hands dealing with pigs, pork butchers and persons engaged in similar occupations. Personal cleanliness of such people is, then, of the greatest importance,

while pigs should be confined, and not allowed to run in yards and dwellings. In 1915, when in England, I wrote: "As swine-herding is an important occupation in Serbia, the possibility of balantidial dysentery among troops operating in that country must be borne in mind." Afterwards, in 1916, I found a few such cases in Macedonia.

With regard to treatment, thymol has been well recommended.

Blood Protozoa.

Protozoa, parasitic in the blood, have caused much illness among soldiers in certain theatres of war. I personally had much experience in the diagnosis of blood parasites, especially malaria, not only in England, but in Egypt, Salonika, and Malta, and still more recently in South Africa. The organisms responsible for malaria and relapsing fever, as well as trypanosomes that may infect man and transport animals, are included among the blood parasites or Hæmoprotozoa.

Insects serve as the chief transmitters of protozoal diseases of the blood. Thus, the various forms of malaria are carried from man to man by certain mosquitos belonging to the Anophe-

Fig. 14.

Fig. 15.

linæ. Lice are responsible for the transmission of some forms of relapsing fever, while ticks (which belong to the Arachnida, another group of the Arthropoda) are responsible for the spread of other forms of human spirochætosis.

Blood Flagellates.

The parasites of the two forms of human sleeping sickness, *Trypanosoma gambiense* and *T. rhodesiense* (with a posterior nucleus in some of its stout forms), are transmitted by tsetse flies, *Glossina palpalis* and *G. morsitans* respectively. *T. brucei*, the causal agent of nagana, which is often fatal to transport animals, is transmitted by *G. morsitans*.

Trypanosomes, whether of man or animals, possess an elongate, snake-like or sinuous body. There is a principal nucleus, and a second chromatin body, usually barlike, the blepharoplast. The blepharoplast is at the posterior end of the body, and from its vicinity a single flagellum arises, which passes over the body and forms the edge of the locomotor organ, the undulating membrane, beyond which the flagellum is continued for a varying distance as a free flagellum (Fig. 14). Trypanosomes multiply

by longitudinal fission, and consequently thinner and thicker forms are found. Some of the stout forms of *T. rhodesiense* have the nucleus posterior, that is, near the blunt non-flagellar end of the body (Fig. 15). As before mentioned, sleeping sickness is spread by tsetse flies. At the same time note must be made of natural reservoirs of human and animal trypanosomes. It has been shown that various antelopes and other big game harbour the trypanosomes of Rhodesian sleeping sickness, but are unaffected thereby. The infection in the antelopes may not be a very heavy one, but the big game act as reservoirs whence *Glossina* can acquire trypanosomes that may be transmitted to man with fatal results, though fortunately the blood serum of many persons is fatal to *T. rhodesiense*. Trypanosomiasis may be controlled by various organic preparations of arsenic and antimony, such as atoxyl, tartar emetic, etc.

Other protozoal diseases which may be encountered by the Forces in India and Mesopotamia are due to the various species of *Leishmania* (such as *L. donovani* and *L. tropica*), the causal

Fig. 17.

Fig. 16.

agents of kala-azar and of Oriental sore. The leishmaniases are probably transmitted by insects, such as bugs, fleas, lice, mosquitos and sand flies, in which the Leishmania may pass through a herpetomonad stage (Fig. 16). The non-flagellate, oval form or Leishman-Donovan body, is the stage of the parasite commonly found in man (Fig. 17). Leishmaniases may be successfully treated by intravenous injections of tartar emetic.

The detection of these parasites and others of a similar nature necessitates microscopical examination by highly trained workers.

Blood Spirochætes.

The chief relapsing fevers are due to two principal spirochætes or varieties thereof. African tick fever is due to *Spirochæta duttoni*, and is transmitted by the tick *Ornithodorus moubata* and allied species. European relapsing fever is due to *Spirochæta recurrentis*, and is transmitted by body lice. Each spirochæte has a sinuous elongate body, with a diffuse nucleus of minute chromatin granules (compare Fig. 10). *S. duttoni* in human blood measures $12\,\mu$ to $16\,\mu$ long, is $0.25\,\mu$ to $0.5\,\mu$ broad, and has pointed ends. *S. recurrentis* varies from $7\,\mu$ to $19\,\mu$ in

length, being commonly about 12μ or 13μ. It is 0.25μ broad Multiplication of these parasites in the blood occurs by binary fission.

Within the gut lumen and hæmocœlic or body fluid of the tick, *Ornithodorus moubata*, the spirochætes (*S. duttoni*) break up into a series of minute chromatinic granules known as coccoid bodies. Some of these granules pass into the thick white Malpighian secretion, which is voided as excrement at the end of a tick's meal of human blood. The Malpighian secretion is diluted with the coxal fluid, and so is able to enter the wound caused by the tick bite. The coccoid bodies thus received, together with some sinuous forms, develop into spirochætes in man. Coccoid bodies and perhaps some spirochætes pass with the hæmocœlic fluid into the ovaries of the tick, infect the ova, and the young ticks are born infected, and so are capable of producing infection in man when they feed.

Spirochæta recurrentis in the louse breaks up similarly to *S. duttoni*, but the mode of infection of man by way of the louse differs slightly. The irritation due to louse bites causes scratching and rubbing, and the lice are crushed on to the skin. The slight abrasion is quite sufficient to permit the entry of the parasite. Rubbing the eyes with contaminated fingers can produce infection. Louse bite alone is not infective. Hereditary infection of lice with *S. recurrentis* or its varieties also occurs.

Spirochæta icterohæmorrhagiæ, a small organism, is responsible for the febrile condition known as Weil's disease, "infectious jaundice" or Mediterranean yellow fever, cases of which have been found on most of the war fronts. The parasite is found with difficulty in the circulating blood, but is much more easily recognized by examination of the livers of sub-inoculated animals such as guinea-pigs. Rats may act as natural reservoirs. Trench nephritis is also stated by some to be due to a spirochæte.

Salvarsan or arseno-benzol and its modifications are effective in the treatment of spirochætoses.

Blood Sporozoa.

The various malarial parasites are the principal Sporozoa found in the blood of man. The life-cycle of the malarial parasites is accomplished in two different hosts, man and certain mosquitoes. In man, the asexual development or multiple fission of the parasite occurs inside the red corpuscles of the blood, and the successive formations of asexual daughter parasites or merozoites produce the attacks of fever. When the reaction of man on the parasite causes the production of sexual forms, and these are ingested by certain Anopheline mosquitos, the females of which alone are able to suck blood, the sexual development is completed in the body of the insect host, with the final production of crowds of sporozoites or infective germs, that are capable of infecting man. Should a parasitized female mosquito suck the blood of man, the sporozoites are injected into the blood

along with the drop of saliva that accompanies the inthrusting of the insect's proboscis.

Three species of malarial parasites are usually recognized.

Plasmodium vivax, the parasite of the so-called benign or simple tertian malaria, causes intermittent attacks of fever every 48 hours. Its trophozoite, at first ring-like (Fig. 18), is fragile or flimsy in appearance and amœboid in shape. When fully grown, it causes enlargement of the host erythrocyte or red blood-corpuscle, in which Schüffner's dots may be seen (Fig. 19). It multiplies in the circulating blood, giving rise to 15 to 20 merozoites (Figs. 20, 21). It produces somewhat fine pigment granules, and has spherical gametocytes or sexual forms.

Plasmodium malariæ, the parasite of quartan malaria, is a smaller organism, and does not cause enlargement of its host corpuscle. It is somewhat compact with dense chromatin, and forms dark, coarse pigment. It multiplies in the circulating blood with the production of six to twelve merozoites. Attacks of fever occur every 72 hours.

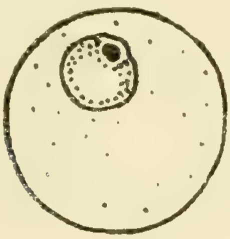

Fig. 18.

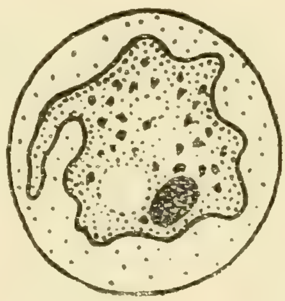

Fig. 19.

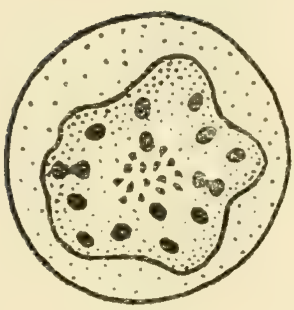

Fig. 20.

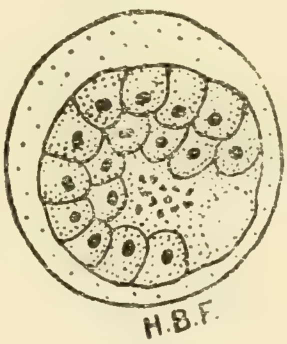

Fig. 21.

Laverania malariæ or *Plasmodium falciparum* is the parasite of malignant tertian, subtertian or pernicious malaria. It usually multiplies asexually in the internal organs, forming up to 32 merozoites. It has characteristic crescent-shaped gametocytes or sexual forms (Figs. 22, 23). Coarse stippling, known as Maurer's dots, may occur in the host erythrocyte. This parasite is more severe in its effects than the other malaria-producing organisms, and the blocking of the minute capillaries of the brain by a sudden increase in numbers of the parasite is responsible

for the cerebral forms of malaria, which may have serious or fatal consequences.

It is well known that malaria was usually considered to be amenable to treatment with quinine. This drug is capable of destroying the asexual generations or merozoites in the blood, but the crescentic sexual forms of the malignant tertian parasites are often resistant to quinine. Recently it has been found that intravenous injections of tartar emetic were effective in destroying crescentic gametocytes in man. The treatment has been tried on a few cases in various places, and has recently been practised in Johannesburg at the Wanderers' Hospital by Orenstein and Watkins-Pitchford with excellent results. In the Balkan war zone there was much malaria in certain valleys and low-lying ground, and quinine-resistant strains of parasites occurred. Cerebral malaria also was relatively common. Anopheline mosquitoes occurred in the neighbourhoods, and there is little doubt that some of the native population served as reservoirs of the parasites.

Were there no Anophelines (which mosquitos are characterized by having spotted wings) there would be no malaria, since the sexual cycle of the parasites is only completed in the body of the female insect. The union of the malarial gametes (male and female parasites) in the lumen of the mosquito's stomach, with the production of a motile zygote or oökinete, is followed by the passage of the latter through the wall of the insect's stomach and encystment on the outside thereof. Enormous multiplicative activity takes place within the oöcyst, and results in the formation of many sporozoites, which ultimately find their

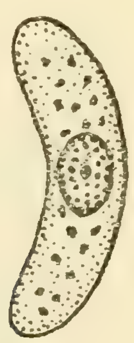

Fig. 22.

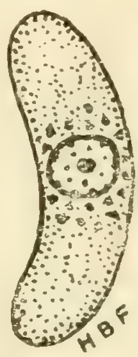

Fig. 23.

way to the salivary glands of the insect, whence they are inoculated into man with the saliva when the insect next feeds.

Anti-malarial campaigns take two forms: one against mosquitos, the other against the parasite in the human host. Quinine and organic salts of arsenic or antimony attack most of the forms of the parasite in man. The main anti-mosquito measures include drainage of swamps and unnecessary pools, removal of all useless receptacles capable of containing water in which mosquitos may breed, the screening of all household receptacles, and periodic oiling of water surfaces that cannot be screened. The use of a mosquito net of fine mesh when sleeping is essen-

tial. European houses should be situated well away from native quarters, as native children can act as reservoirs of malarial parasites, they themselves being relatively immune from their effects. Former sufferers from malaria, who are still subject to relapses, may be responsible for new malarial outbreaks, if they live in districts where transmitting Anophelines occur.

In this paper, the importance of parasite carriers and reservoir hosts as potential dangers has been frequently mentioned. But the very existence of such parasite carriers has also a reassuring side, in that it indicates that pathogenic properties among parasitic Protozoa may work themselves out—in other words, that non-pathogenic strains may be produced in time. This is due to the gradual establishment of a mutual tolerance between the host and the parasite, whereby they live in harmony with one another. It is obviously to the disadvantage of the parasite to bring about the premature death of its host, and thereby shorten its own existence. Mutual tolerance, relative immunity and the gradual production of non-pathogenic strains all afford illustrations of the Balance of Nature.

Figs. 1, 2.—*Entamœba histolytica.* Fig. 1, Trophozoite showing nucleus with karyosome and centriole, and two ingested red blood-corpuscles. × 1,300. Fig 2, Typical cyst with four nuclei and chromatoid body. × 2,000.

Fig. 3.—*Entamœba coli.* Typical cyst with eight nuclei. × 2,000.

Fig. 4.—*Trichomonas hominis.* Flagellate form. × 2,000.

Figs. 5 to 7.—*Chilomastix mesnili.* Fig. 5, Flagellate form. Fig. 6, Oval cyst. Fig. 7, Lemon-shaped cyst. × 2,500.

Figs. 8, 9.—*Giardia intestinalis.* Fig. 8. Flagellate form. Fig. 9. Cyst. × 2,500.

Fig. 10.—*Spirochæta eurygyrata.* Motile form with diffuse nucleus. × 3,000.

Fig. 11.—*Isospora hominis.* Oöcyst containing two sporocysts, each containing four sporozoites. × 1,000.

Fig. 12.—*Eimeria stiedæ.* Oöcyst containing four sporocysts, each with two sporozoites. × 1,000.

Fig. 13.—*Balantidium coli.*—Ciliate form. × 1,000.

Fig. 14.—*Trypanosoma gambiense.* Flagellate form. × 2,000.

Fig. 15.—*Trypanosoma rhodesiense.* Flagellate form with posterior nucleus. × 2,000.

Figs. 16, 17.—*Leishmania donovani.* Fig. 16, Herpetomonad stage. Fig. 17, Non-flagellate stage or Leishman-Donovan body. × 1,500.

Figs. 18 to 21.—*Plasmodium vivax.*—Fig. 18, Young ring form within red blood-corpuscle. Fig. 19. Amœboid parasite showing pigment Fig. 20, Multiplying form or schizont. Fig. 21, Cluster or rosette of merozoites within the red blood-corpuscle × 3,000.

Figs. 22, 23.—*Laverania malariæ.* Crescent-shaped gametocytes. Fig. 22, Male gametocyte. Fig. 23, Female gametocyte. × 3,000.

(*Read July* 3, 1917.)

Col. JAMES HYSLOP,

D.S.O., V.D., M.B., C.M.., S.A.M.C.

(*Born 3rd March*, 1856; *Died 5th October*, 1917).

The death of Colonel James Hyslop occurred at Pietermaritzburg on the 5th day of October, 1917, after an illness of about two months' duration.

From the beginning of the present war the deceased had been on active service, first as Assistant Director of Medical Services at Pietermaritzburg, then Deputy Director at Durban, where, owing to the strain of overwork, his constitution gave way, and he was consequently released from military service in August, 1917, an invalid.

James Hyslop's career was both varied and interesting; his activities were manifold, and his sympathies wide.

He was born in 1856 at Kirkcudbright, Scotland, his father being Mr. Thomas Hyslop, of Woodpark, Kirkcudbrightshire. He was educated at Hutton Hall and at Edinburgh University, where he was a pupil of Sir Wyville Thompson, of Lord Lister, and temporarily of Huxley. He graduated in medicine at Edinburgh in 1879, subsequently specializing in mental diseases at Berlin, Vienna, and Munich; and he held an appointment as Assistant at Morningside Asylum, near Edinburgh, under the eminent authority Clouston, prior to his coming to Maritzburg as Medical Superintendent of the Natal Government Asylum (now known as the Mental Hospital) in 1882. He held the latter position with distinction until his retiral in 1914.

On arriving in Maritzburg he found the asylum a small building, containing 71 patients, and perched on a bare hillside. The inmates were, in the light of modern methods, comparatively neglected; but Hyslop set to work, and in course of time the patients were provided with comforts and amusements, the accommodation was expanded, and the grounds assumed the appearance of a cultivated and well-planted demesne, until when he retired his charge had become one of the show places of the town, with alas! about ten times more patients than when he took over 32 years before. Mention might be made here of the long and able assistance rendered to Colonel Hyslop by Head Attendant Davidson, one of the landmarks of the institution.

At an early age of 17 Hyslop's martial instincts led him to join the volunteer movement in Scotland, and he was, with only one short break on his arrival in South Africa, in military service until his death.

At the outbreak of the last Boer war, Hyslop was a Lieutenant-Colonel and O.C., of the Natal Medical Corps, and was with our forces besieged in Ladysmith. For his excellent services in that campaign he was rewarded with the D.S.O.

Unfortunately, a short time before the siege was raised, he contracted enteric, which left him with a somewhat impaired constitution. On his recovery he took up his military duties in Maritzburg with his accustomed enthusiasm. As an evidence of

JAMES HYSLOP.

the traditional British spirit of the man, it was a satisfaction to him to know that he never once, during the whole length of the siege, took refuge in a dug-out.

Colonel Hyslop next saw active service in the Native Rebellion and the taking of Dinizulu. He was specially mentioned in despatches for services rendered during this campaign.

While mental and military work were the two leading occupations of his career, the Colonel took the keenest interest in medical politics and medical affairs generally. He was President of the Natal Medical Council from its origin in 1896 until his death, and for many years he was President of the now defunct Natal Health Board, and was a member of the Government Commission on Plague. He was also an active and prominent member of the old Pietermaritzburg Medical Society, and of the local branch of the British Medical Association, of both of which he was elected President more than once, and he was a delegate to the annual meeting of the Association in Belfast in 1909. In 1911 he was Medical Officer in charge of the South African Coronation Contingent.

In the formation of the South African Committee of the British Medical Association he was one of the leading spirits, and was elected a member by his branch.

As a host and organizer he shone conspicuously when President of the South African Medical Congress, held in Pietermaritzburg in 1905, and when President of the South African Association for the Advancement of Science on the occasion of its session in the same town two years later. His presidential address on the latter occasion was an admirable résumé of the advances made by applied science in general and by medical and surgical science in particular. The affairs of the Association have had his warmest support as a local representative on the subsequent Councils of that body. The University of the Cape of Good Hope also had him as a member of its Council.

In the city of his adoption he identified himself with many societies, having for their object the good of the town and the elevation of its people. Among these societies the following may be mentioned: The Botanical Society, the Horticultural Society, and the Natal Society, of each of which he had been a President.

Although he wrote many fugitive papers, only one work claims him as its author, "An Investigation into the Anatomy of the Central Nervous System."

Leading a life of strenuous endeavour as he did, he had little time for mere amusement, but he loved a good play, and the local theatre saw him not seldom.

In his younger days he greatly enjoyed a day's shooting, and latterly he occasionally snatched an afternoon at golf or an evening at bridge, both of which games he played "as well as a gentleman should."

He was the soul of generosity and hospitality, and many there are who will remember with pleasure the good times spent

in his company. His first wife was at one with him there, and endeared herself to all; while his second wife, Lady Steel, widow of a former Lord Provost of Edinburgh, supported the traditions of his house and shed the lustre of her charming personality over all.

The Colonel had the true diplomatic spirit. He instinctively knew how to gild the pill and dissipate opposition; whilst his enthusiastic nature, tempered by a full measure of Caledonian caution, was of the greatest advantage in all his undertakings.

The admiration of his friends found a fitting climax when they presented him with his portrait, executed by the well-known Edinburgh artist, Fiddes Watt.

He was a *persona grata* in Government circles; and he deserved well of his country, not only for his long, exemplary and meritorious services, but by reason of the sacrifice of health and life in the present great struggle. Although he died not in the turmoil of the front where he would have chosen to be, had health and age permitted, yet he did his duty well like the gallant soldier that he was, and South Africa and the Empire are the richer for his honourable and distinguished career.

D. C. W.

OXANS.—Dr. C. Scott Garrett, in a recent issue of *Science Progress*,* calls attention to what he calls "one of the most important advances which have been made in the domain of inorganic chemistry of recent years." The reference is to a series of investigations made by A. P. Lidov with regard to the reactivity of carbon, the results of which have been printed in the Reports of the Kharkov Technological Institute.† By aid of a catalyst he claims to have succeeded in getting carbon to enter into slow combination at the ordinary temperature. At first α-monocyanogen and β-monocyanogen are formed, and these afterward give rise to α-oxan (OCN) and β-oxan (ONC) by the addition of oxygen. These oxans exhibit an analogy to carbon dioxide, and so Lidov was led to search for them wherever carbon dioxide occurs in nature, *i.e.*, in the air, in natural waters, and in mineral carbonates. He found the density of the carbon dioxide from calcite to be considerably lower than theory requires for CO_2, while the gas from marble and dense limestones was higher than, and that from chalk and aragonite approximately equal to the theoretical value. The low density of the calcite gas is due, it is suggested, to the presence of quantities of α-oxan, calcite itself consisting largely of calcium oxanate. If it be indeed the fact that calcite contains nitrogen, then agricultural lime from that source will be specially useful as a fertilizer, and at the same time a new vista would open up in connection with the problem of the fixation of atmospheric nitrogen.

* (1917), **12** [45], 25-27.

† *Journ. Soc. Chem. Ind.* (1916), **35** [24], 1260.

SESUTO ETYMOLOGY.

SPECIMEN (SESUTO) ETYMOLOGICAL DICTIONARY.

By Rev. WILLIAM ALFRED NORTON, B.A., B.Litt.

This paper does not profess to be a working dictionary for beginners. It is submitted to the indulgent criticism of Suto scholars, and its method proposed to Bantuists as an *apparatus philologicus* for dealing with the several languages and dialects (the former are said to number 182, the latter 119), with a view to comparison. The mere saving of space in reference would be an enormous boon, similar to that conferred on classical criticism by its now familiar *apparatus*.

The main principles, then, of my scheme are as follows:—

1. The need of *complete etymological arrangement*, including the derivative nouns, in Suto, corresponding to those of Bryant and of Kropf in Zulu-Kaffir respectively. This had been done in German by Endemann, but not yet, so far as I know, in English. Endemann's great work has, of course, been invaluable, but he is not primarily concerned with South Suto, with which I am most familiar. My honoured friend, M. Dieterlen, has most kindly allowed me to make use of his labours on this dialect, and I have also to thank the patience of a native colleague (the Rev. N. Leballo) and pupils.

2. The principle so admirably worked out by Endemann of the significance, even in Bantu, of *tone*, which I have exhibited by acute and grave accents for up and down tone respectively. The same phenomenon appears, not only in other African groups, especially the West African, and (as is well known) in Chinese, but also in English, and indeed in nearly all language. Thus a school teacher cries, "Stánd!" but "Sìt!" We say to a dog, "Gét úp!" but "Lìe dòwn!" So in Suto *áka* is to hóver, but *àka*, to lie, in the still lower sense of deceit; *àla* is to spread below, but *ápa* is to spread above (*cp.*, "Spreàd it there," but "He spréadeth out the *heavens*" (*lo-api* in Chwana). *Bìpa* is to hìde, and *Èpa* to dìg in the earth, but *Épa* is to cáll. So *bÓka* (with broad *O*) is solemn praìse—in alarming contrast, as missionaries know to their cost, with *bòka* (*q.v.*), often spelt without difference. *Bôpa* is to sulk or (g) lower; both, again, in tone and vowel distinct, except in spelling, from *bópa*, to moúld. Again, *àna* is solemnly to sweàr (remember the "tone" of Hamlet's father's ghost), and *èEka* is to betrày, but *éka* (with shut *e*) is to wave (brandish), and *Ékela* to add. To return to homelier levels, *Eta* represents "foòt-slòg," the humdrum of native tràvel (not the romance of *our* rapid "trável" *de luxe*), and *bòta*, the dull if soothing job of smoothing mud-plaster. I venture to commend this parallelism between these Suto tones and our English ones to the notice of general philology. I have stated elsewhere that Bantu philology, in coming itself to light, tends to throw light in turn on general philological problems. This extraordinary psychological permanence of tone, and pre-

existence, as it were, to all confusion of tongues, will shew those who can agree that any good thing can come from the study of things African how valuable a stimulant such study is likely to be in view of the whole science.

I have gone on the principle that the tone of the stem word runs through the derivatives. I am quite aware that there are exceptions, but they would take us too far to discuss at present. We shall, however, do well to suspect the affiliation, however likely seeming, when the *tone* differs, and this accounts for a number of the notes of interrogation with which I have besprinkled the vocabulary. Observe that the up tone is the normal, representing a straightforward idea; thus *bÔna*, see! Students of Suto, at least, will find no real difficulty in following my scheme of presentment, if they will remember that *one* full point stands for the *stem word* at the head of each paragraph; a *double* full point for the last-mentioned verbal *derivative*, when there is any doubt which is referred to.

Single and double hyphens change the final *a* of the stem-verb or last verbal derivative respectively into the flexion immedately following the hyphen.

This notation may puzzle for a few moments, but is easily learned, and has the advantage of exhibiting about a seventh of the Suto vocables (with their meaning when not fairly obvious from the etymology indicated) within the space of these few pages. Study of these will reveal not only the extraordinary logical character of these Bantu tongues, but a wealth of quaint aptness of expression in the derivatives. For example, take the variations of *bOpa*, *bea*, *bata*, *etsa*, *fahla*, or *ala* (cp. *ñoale* for circumcision girl with the Northern use of *aloga* and the *galo* dances in Bondei). Again, how neatly *beola*, to shave, connects with *bea*, to place, of which it is the *inversitive* form—to put your hair away! And how natural (alas!) is the connection between *ho betha*, to cudgel, beat, and *lebethe*, strong drink. But this appears to be only in North Sesuto; in Basutoland (shall we say?) there is no such connection whatever.

N.B.—As D does not occur in true Suto, and C is not used, except in the compound sound represented by Mabille by *ch* (of which I postpone the treatment), the alphabet passes, as will be noted, from B (*double*-lipped) to E.

X, Xosa. Z, Zulu. Chw, Secoana.

D, Found in Mabille's Suto-English Dictionary, revised by H. Dieterlen (not in E).

E, Found in Endemann's "Wörterbuch der Sotho-sprache" (not in D).

. means — repeat the stem-verb; - modify final vowel as given;

. . repeat last derivative verb; - - modifies its final vowel.

The *mo*, *bo*, *ho*, *le*, *se* prefixes are represented by their initials; so also the *ño* form of the first prefix. The chief noun endings are in *-i* (active) and *-o* (passive). Derivative nouns are bracketed. *A*'s and other vowels when repeated are omitted from the verbal derivative endings. Thus from

aha : (*ñ.* ; *k-O*) ; *-is* (*m-i* ; *b-O*) ; *..n* (*y*) ; *-ell* *..n* *-elts* *-olh* mean : (*ñoaha* ; *kahO*) : *ahisa* (*moahisi* ; *boahisO*) ; *ahisana* *ahisanya* ; *ahella* *ahellana* *aheletsa* *aholoha*.

O and *E* are broad vowels. The verbal ending *-eh* is intrans., *-oh* and *-ol* inversitive ; *-y* (producing sibilants) causative ; *-el* relative ; *.n* reciprocal.

Grave and acute accents mean low and high tone, especially on the stem syllable, and are mostly preserved throughout the derivatives.

N. stands for the dialect of the Northern Transvaal.

A.

N.B.—The noun class without syllabic prefix begins with *k*. *ñ* is the sound of *ng* in *sing*, as in Chw. (not as in Spanish). Topographical exigencies prevent a better symbol.
tS = ts aspirated.

ába, deal out (*l.na* broad flat dish D : *l-nyana* small pot with wide opening, individual ; *k-O* ; *s-O* : *s-i* cheerful giver, *s.*) : *-el* deal out to (*m-i* ; *m-oa* sharer ; *s-O* share ; *k-O* contribution) : *-ol* take away share (*ma.* one's lot) : *abaka* deal with both hands.

S-ò is a pit dug to unearth a jackal.

áha, settle (*ñ.* *year*, minimum settling time to get in harvest ; *b-O* building ; *l-O* home ; *s-i* good builder, *s-O* something built, *li-O* building material ; *k-O*) :*-oll* break up : *olh* make room : *-ell* settle long ; *..n* be at peace, settled : *-eltsa* shelter (*k-O* sunshade) : *-is* let settle peaceably, make prosperous (*k-o* peace, *kh-o* competition) ; *..n* live near (*k-O* living in peace).

[*àhla*, *open* :] *-olh* become open D ; neuter-pass. *-oh* and *.m* be open (*m-o* opening ; *l.* silly yawner) : *- -el* gape at ; *.mis* gape : *-el* slap : *-ol* judge (*m-i*, *k-O*), discern, conclude, lit. separate ; *- -el* condemn D, acquit E. !

á-ila, go tiredly.

[*a-káma*, be astonished N] *-el* interfere : *-ets* interrupt. Cf. *okamela*, *áka*.

àka, tell lies (*l.*, *s-E* dissembler ; (ra) ñ-o, 2nd son born after death of 1st ; (ra)ñ-oane daughter do.) : *-el* lie for a purpose (*m-i*) : *-ets* belie : *ik..* be a hypocrite (*m-i*), make oneself tell lies for a purpose.

áka, hover, kiss (*m-i* ; *b.* and *s-i* sens. obsc. ; *b-o*, *j-o*, haste ; *ka j...* at once ; *s-o* moment ; *k-O* kiss) : recipr. *.n* ; *.ny* reckon ! (*k-O*, brooding, reflection) : *.rets* include (*k-O* summary), e.g. *lefu le ..ñ*. plague, all-including 'death.' *-of* haste (*k-O*) ; *-ol* to eat nice food (*s-o*, *e.g.*, new grass) in its season (*m-o*), get fat.

ákha, swing, brandish : *.rets* come forward to catch : *-ol* throw up, recook *joala* dregs.

àla, spread (*m-o* bedding ; *s.* warrior's crest, flesh under the knee D ; *ñ-e* circumcision girl ; *ma-ali* blood, with *bo-m...* *matle*, *mabe* good and ill luck) :*-el* place stones under meat in pot, or apron of skin (*kallane*) under a child : *.m* brood, sit,

approach, defend: ..*is* set (hen): -*oh* go to pasture, spreading over it, -*os* to herd (*k-O*): -*ol* collect bedding, run away (*s-o* 'pursuit,' a dance): -*im* lend (*m-iñoa* borrower): .*ts* be level; .*mets* poor out all at once.

For *alafu* and *joala*, see *ela* measure.

áma, touch (*k-O*): .*ny* compare: -*oh*, take away, ..*n*, relieve, answer, each other (both make *k-O* robbery): --*el*, receive burden, etc. (*k-O*, reception as guest, adoption): -*ol*, loose.

án-an-ya, exchange (reciprocal termination -*ana* reduplicated).

áná-fa, N become many; so .*l*.

àna, swear, establish by calling on a greater (*b-e* reflection, *l-o* plan, *k-O* oath): .*n* remember each other; *antSa* take oath.

áneha, spread to dry; *anela* spread on; *anetsa* caus.; *ik*. bask D.

anya, suck, cf. *hama* to milk, and *nya-nya*: -*es* suckle (*m-i*); -*ets* milk into one's mouth (also used of a big calf).

Le- '*Aoa*' ('No') is a N.Mosuto.

àpa (grip) be in-distress, think much, talk of.

(*lelo-i* cream, cirrus clouds): .*ra* put on (esp. neck E) (**m-O*, †*s-O*); -*ol*(*l*) uncover; -*olots* scatter; -*es* clothe: -*oh* be clear, bare; -*eloa* of cloud breaking through.

[*ára* to open swelling:]

.*ba* answer, be open to caller's will; .-*el* answer from distance: -*ol* ..*n* (*y*) divide, separate, (*k.O* portion); -*oh*, *arubela* breathe in vapour (inhale medicine *m-o*), *cf*. *Ora*: *athamela* warm oneself (*m*. where sun falls through opening, gentle warmth of morning sun). From *araba*: *k-O k-elO*.

àta multiply, so -*oloh*, *ñ*. *fala*; -*olos* expand, tr.; -*is* (*k-O*).

For (*b*) *atamela see* B.

àtla make prosperous, strong (*ma*. strength, *b*. folly! *s*. palm of hand): -*eh* be prosperous.

B.

N.B.—The prefixless class sharpens initial *B* to *P*.

Initial *mo-b* contracts into *mm* written '*m*.

baka, let go, let stand, excite, (*l*. cause, occasion, of time; *s*. room), so -*elts* -*el* give room, *l-e* is hemp, *l.lla* medicine for polygamists.

(*ba*)*baila*, avoid saying what should be said D (walk painfully).

baba-tsa, *Z*. -*za* (move on high) be astonished (*p-O*), Cf. *babala* N. be passionate (*p-i* bushbuck, D *p*.).

baba, hurt, be *bit*ter, sick ('*m*-i: '*m*. cattle sickness, *l*. and *bo-batsi* nettle, *p-o* sickness, *p-i* and *pabela* spot in eye, *p-i* roasted corn): pass, be frost*bit*ten (*l-O* frost): -*el* burn (-*ets* be hard bark a stick, N.; so S.Suto *s-i* scurf): -*is* make bitter, cause frost; .*sel* hurt.

bala, count, so read (by pointing to letters), but in ZX *bhala* is to write (*p-O*; '*m*. *l*. spot of colour; *p*. scar on leg of one who sits too near the fire, a small thing): -*el* promise (*p*-(*an*)*O*). In some dialects (*l*. is the new moon), .*m* is used of the new moon's appearance as a strip of colour. (*l*. is also dry

* Seam of a curtain; but now, way of putting on dress

† Trinkets, especially on neck (originally).

flats, cf.) *balla* to have drought (*l.*), *-is* dry in sun, *l(pali)2* waste veld. *Balola* is to be bitter, cf. Chw. *balela* feel choking in throat; *balolla* slander openly (*p-(an)o* denying relationship --mutually): *balloa* choke in nose: *baloha* be full (in belly), *p-O*. *Balla* is also to put lathes (*l-O, p-O*) on a house (*lebali* is a mark on face, place over door E, *lebaleoa*, gums), *Baballa* (*p-O*), care for, reckon for, is perhaps connected.

'mane is X'*um-bane* lightning, cp. (*panya*)2 to blink.

bapa, stitch or weave through, Z. *bamba* (*ma*. neighbourhood): *.n(y)* be (put) over against: *.l* wrestle, play (*p-i, p-o*): *--is drill* (*p-o* also play; *.ll* make game of: *cp.* .ts sell (*'m-i* trader, *p-O* trade), *-ol* peg down skin, spread net; neut. pass, *-oh*.

bata (for X. *banda*), congeal, (of water) freeze.

báta, smite flat (*l-O* floor, *l-e* vegetable; *s*. groper, hoofless beast like dog, cat, with dim.; *l-ooa* place, quarter); *.ll* lie flat (*s-i* sentry): [*.ma* in X means lie prone, hence] *l..* heat, *.ny* run beast unmercifully (*ventre à terre*, cf. *.m*), throw to ground; *.ol run very fast*: *-ell* hit wound on head; *-ol* hammer spear, etc., to sharpen, *-eh* plaster a wall; *-oloh* fall off do.; *-el* trample earth floor, *se-batolo* is a place beaten hard, *cf. pataolo*. *Patolo* is a hard stone to sharpen millstones.

Ho re 'bàtha'! is to arrive suddenly: *mab* .is feet turned out.

bátla, seek (*p-O*, *.m-o* edge, *e.g.*, of bayonet; *l*. open forum): *-is* help seek; -*-is* seek carefully.

-bé, bad: *l*. famine; *li*. ox given in condolence to sick chief, or slain for buriers, *.f* become angry (*p-O* violence); *.fel* (*s-i* hothead); *fis(an)* &c. *.fol* act violently; *..k* speak angrily.

béa, place (*ma-o*, where a thing is placed; *s-O* something *placed* to bewitch, drug, target, prize: *p-O* placing: *peo* seed, has both vowels shut): *.n* unite, *.ny* arrange (hair, etc.); *-heh* have patience; *-elts* engage young bride: *-oll -olts unlade*. *LebEElO* is a fool, *'Mei* is one who gives land from the chief, *-is* to race-horses (*p-O, l-O*): *lpea* do homage (*b-O*), *L-oana* a true man; *-ol*, shave (*'m-i, l.*), *be..* also (*s-o* razor, i.q. *lehare*).

veha, report, esp. death (*p-O*, *p-i*, *'m-O*, *s-O* offering to chief in kind, esp. corn, on report of councillor's death).

bEka, cut flesh in strips (also to master, tame), *PEkanE* crack on lips; *'mekeloa* flesh on ox-ribs; *le-bEkO* nose spoon, *se-bEkaeli* bodkin: *bEkEnya* glitter. *IpEka* fight against feeling. *Se-bEka* ox killed for sale.

bèka, bring home bride; *.r(o)a* to couple, of rams and he-goats (and female).

bèla boil (*ma*. dandyism; *p-O* heart; *le-bele* male antelope); *bebelO*, haste, a quail; *.el* be anxious, doubtful, ignorant (*p--O*).

béla, drive home: *.nya* revenge.

For *le-bÉlE*, v. *tsoala*. *LebElE* is Kafircorn. *'Mele* is body (*mob..*), *seb...* is self, but *'mElE* is teat, *le(bElE)2* manna-corn, wild plant with edible grape.

bÉlEha, take on back, lie in (*p-i*, *p-O*): *-is* help delivery, *so m-i* (*p-O*) midwife(ry): *belEsa* lade (*p.* packbeast, *p-O* burden).

bèsa (? from *bèla*), roast, make fire, *'m-i* cook: *s-O* hearth; *l-è* milk; (*'M.* April): (*besa*)2 be very hot, run slowly; *-elets* put more fuel under (*'m-O* smoke medicine, piece of meat cut off roast on fire).

bEnya, glimmer, (*l.nE* ornament), *bEntSa* polish.

le-bEpa, potsherd, clan.

bEra, talk foolishly (*l.nE*). Also *bEbEra*. ?*-eh* overcooked, spoilt. Cf. *bEcha* speak much (*b-e* chatterbox), *perola* be loud, etc.

béta, choke, ravish (*'m-oane* surprise attack: *s-e* liver, endurance, *P-O* drowning), *.pelo* take courage: *.n wrestle*: *-ellets* coerce. cf. *pEta* pinch, (*bEta*)2 *Chw.* murmur (*b-E* outpoured blood; *l-E* spleen). *BÉtha* in N is to cudgel. ? hence *l-E* strong beer.

betsa, strike, throw (*s.* weapon; *p-(an)O*, e.g., a duel; *'m-i* guard, *s-i* good shot). ? *l-O* crack.

bétla, hew (*eg. tsela*, *s.* block, *'m-i* carpenter).

bEba, be quick, shoot far, *-el* wander round; *-is* make light, help oneself, *-ol* diminish, (*s-E* abscess, *b-E* lightness. Also *b-O*).

bo-bì, wasp, *ma-bife* ragged speech, *'mìla* path.

bitsa, call (*l-O* name; *s.* (magic) plant; *p-O* assembly): *-oll* make nameless, dishonour: *biletsa* (*p-O* invitation):

bílietsa, cover, brood.

se-bìlO, antimony, *pìlo* and dupl. black powder.

bílika, roll, writhe: *so.n(y)*; *Biloha* eddy, ferment, caus. in *-sa*: *bitoha* emerge; *bitoloha* retch. (*'mili bili* great multitude).

bína, sing, dance (*'m-O* song, *s-i* singer): *-tSa* play instrument.

bìpa, smother, hide (*b-o* (*s-elo*) hole (for Kafircorn); *s-o* curtain):

bípa, spring up, swell (*'m-O* swelling; *l-i* belly-fat; *ma-bípjoa* fermenting Kafircorn): *-el* blow up, pass. be stopped up.

(*bitla N*) make stone-heap grave (*l.*).

le-bó, *m.* (brak) earth; *s.* inside of animal, cf. *bopa*.

bóea return (*ma-O* people coming back; *'m.nÉ* crab; *s.* threshing floor; *'moi*, perennial grass [?(*b*)*bOea* fleece, hair, *l.* single hair, not of head], also *l.* in N.—W. wind, but in S.—N., whence Basuto came; *p.* flat treeless country, (?) Kalahari; (*b*)*boi*(*f*) fear, *.fis*, frighten, *'moifO* fright). *BOiba* be fuddled.?

bóela (rel. of preceding), pass, become rich: *boella* turn back and back (*'m-i* yearly calving cow): *boelan(y)a*(*p-O* reconciliation): *boeletsa* fetch back (*l.* one who practices a thing): *boetsa* bring back, enrich (*'m-i* appeaser). *Busa* make turn, rule (*'m-(is)i*, *'m -noa*, *'m-o*, *'m.pelo* medicine

against weariness): -(*el*)*ets* (& with *ll*) bring back: -*oloh* get undone again, *caus*. -*olos* also to avenge oneself ('*m-i*): *busetsana* give back to one another.

bòba, wane, humble oneself: (*le-buba* cattle-disease; *le-bòbó* kindness) -*el* shew do. -*orana* remain still, shiver: -*osel*. -*othcha* smile. -*ol* moan (*s*. yellow wasp).

bochoha, to peel after a burn (*se-boche* stone, etc., with holes).

bOfa bind, *inspan* (*l*. pack-beast), *l-E* grass-band, '*m-O* girth, also *s-O*): *ip*., *bof*(*el*)*ana* recip.; -*ell* intens. -*oll* outspan. - -*is* help in this; refl., and of -*ollel*, and recip. of last.

bóha, look at, admire (*s-oli* watchman). ? *bohola* bark.

se-bOhO abscess in neck. (E).

bOka, praise, thanks (*s-o* totem, cry). . . not be able to hold up (*l-O-O* speaking with a big voice, awkwardness).

bóka, rake, be in straits between two things ('*m*. feast, meeting, *k'am* . . . the whole lot; *s-ú* sweet fattening grass; '*m-o* chaff): commit forn. ('*m-i*), -*ots* handle, e.g., snuff. *Phóka* fan (*s-i*) *cf*. *foka*. -*ell* rake together. *Sebòkó* is a worm.

b*Ola*, rot (*ma-E* fem. pudenda; *s-u* foul carcase, *b-u* cf. *le-bOlla* great damage).

bólaea, kill ('*m-i*; *s-i* also vampire, *s-O* weapon, *se-bolaoa* dead beast, *le-bolE* dead thing).

bol(*el*)*a*, speak of; with *ll*, tell to. *Búa* talk (*p-O*). -*is* (*p-O*). . .*n* (*p-O*) -*el*(*l*) plead for. But *bù*(*h*)*a* skin.

ból(*o*)*la* go out [to rites, war, journey] (*l-O* circumcision, '*m-i* one taking part in it).

le-bólu, dewlap, cf. *pou-nama*, Chw., and Z. *imbovu* inner lip edge. ? *s*. . . rump, *cp*. *s*(*bele*)^2.

bóloka, keep ('*m-oa* ward; *s-elO*, *b*. . . . place of keeping, grave).

se-bono rump, anus, X *um-bunu*.

bOna see (*l-E* lamp; *s-O* vision) -*el mosali* look at woman impurely, *bonya* smile (l-O).

bOpa, sulk with fight, growl; *so* -*oloh*.

bópa, mould ('*m-i* '*m-uoa*, '*m-O* manner; *s-i* mould(er), oven; *l-O* bank; *mo-bó*(*u*) soil, *cp*. *lebu* brackland, ? *sebu* cowgut. *s-elO* form, mother! *p*. . . womb).

bOra, be thin.

bora, lie down (*l-o* dung heap); .*m* lie flat.

bOta, smoothe a wall (*l*., *s*. big heap, '*m*. mass, *l-e* a boil; ?'*mote* larch; '*motoboto* heap of earth, also *se*(*boto*)2.

botha, lie (of cows after food), cp. *phutha*.

bula, open (*s-O* foul wounds), -*ul* blow (?*se-bubulana* musket): - -*el*, i.q. *butsoela* (*s-O* bellows, '*m*. leting): *uloh* get blown up.

buretsa crush instantly (?*onomatop*.).

bóulela be jealous (of the man); -*is* caus. Cuckoo *buba* D *bubu* E.

bútsoa (?*bula*) be made to open, ripen (*l*.*pele*, 1st fruits, '*m-ela* strong leting).

mùtla hare; cp. .*bótlana* small, and *leb* . . . calf unweaned.

E.

N.B.—Prefixless nouns take *K* like the *A's*.

As pron. has up tone; as affirmative, down tone. Both shut.

èba, swing, rock (*l.* dove), *.mahlo* become dizzy, *-is* dazzle, *-el* wave.

ebola peel, (*.n*), *-eh* peel, *-ots* finish off new pot; *eboha* get peeled.

eEna, 3rd pers. pron. (*ena self, b.* relatives, *Sw. enyewe*).

[*EfEla*, guard] *s-O* what lasts, *seEfo* hauberk.

ehi-eé in songs, a refrain.

eisa, despise

eka, cut the navel string (*m.* comrade, E).

Eka, betray, trick (*m.* jugglery, *m-i*, *m-o* deception), *.n*, *-is*, *ik..*

éka, brandish, *-el* carry on the hand, move, ebb (of flood).

Ekela (*Okela*), *Eketsa* add, *ik..*, *..n..*: *-eh* increase, *ekelletsa* add to. *-ets* give more to, *.n*.

(*e*)*Ela*, run clear, or become so (*m-i* water-furrow, line, *s-i* beam of light or wisdom; *-is* make shine, dilute (*cf. ma-etsi, metsi* water). *-elloa* is (*Ela*)2 meditate deeply, e.g. of a dying man, cf. *m-oane* sick-fancies: *l-ane* fringed skin of warriors, cf. *se-ala*? (*El*)*Eletsa* advise (*m-i*, *s-o* reflection): *-eh* be advisable; *-n* recipr.

Ela to measure; *.tlhoko* give thought *m.* mass, *s-o* quantity, 1-E proverb).

elimola yawn, Z. *zamula*.

Ema stand (*l.* horde, *s.* word, standing, congregation: but *seema* is from *ima*); *.hala* mount (*m. nosi* one standing alone: *l-o stature, s-O b-O* also); *-is* - *-ets, ik..* place before oneself *-el*, . *.n* agree, *-ell* oppose, , *.thoko* stand aside, . *.n* fight; *.el* insist on, *ik-el* excuse self (*m-i*, *b-O*).

Emara conceive, *cf. ama*: *-is*, *-el* soon after childbirth; *.matSehong* while unmarried. *Emola* is the beginning of *emara*, *-oh* go from behind pregnant.

Éna be rich (*MoÉno*), *entSa*. (But *mo-ena* younger brother V.S.) Z. be thick with bushes; (ea na).

eo is the pron., *eO* the adv. "there" *hOna*, but subs. pron. *eOna*.

Epa dig, *-el* bury (*m.khuti* hartebeest-bull, from action of forefeet; *m-o* mine) *-oll* root out, *-el*, *ik.* . dig out for self.

Épa sing, call together. (*s. pitsO* chief).

Éph(*f*)*ola* rescue burning meat, help; *.n; ik.*: *ephoha* recover.

Eta, travel (*l-o*; *m-i* : *m-o* child's skin-hair, sinew thread, *m.* broken pot) *-is ñoetsi* take bride to groom; *.mótho pele*, 'prevent'; *-el* visit, *..n*; *-ell pele* precede : - *-ets pele* send on before; so with one *l; ik.. pele* push in front.

Etha, reel. *éthimola* sneeze, (*m-o* cottony plant, which makes sneeze).

Etla? (*m.*, *m-o* care, *m-o* also custom); *-oh* be scattered.

ētsá make [like], treat (rom *Elá*?) (*m. libe* sinner, *m-E* mane); *.n* do to one another (*m..*best man, bridesmaid); *k.*, - -is pretend, *-is* teach, imitate, - *-n*: *-eh* be practicable. *-ets*(*n*),

-oll, undo, *.-eh* undoable; *-oloh* liable to come undone, *.hala* happen, & *.hats. etsclletsa* caluminate. *.n. ik.*

F.

N.B.—The Prefixless class changes *F* into *Ph*.

fá give away, not mere *n(a)-ea* (*l.* inheritance; *m-ho-loli* Triller, pl.*me..* *se-fo-ntoane*, *strong* person - - "making war"; *s.batho* munificent; *ipha; -is* give out cattle (*ma..*) to keep, - *-ets*; *.n* be generous (*m- -E* yellow wood tree), - -*y* *-miss*; *.ntS* make miss, betray; *.noll* retake gift, *iphella* feed.

fafa give away, carelessly, lie or be light: -oh grow tall. (*fafola* one well set up, sprain oneself), *li.* string of beads, thin congregation.

fá(le)? indeed (lit. there)?

|*fafara*, i.q. *fefera* winnow|: *-ets* go here and there quickly.

|*N fàfála*, become light| *fafatsa* sprinkle (*l..ne* shower i.q. *lefai*).

fafiella, patch up thatch.

faha, pour into, i.q., X *faka* stuff (*m-O* viaticum. *s.* bead): *-oll* take down, Z. *pakula* (castrate horned cattle).

fahla, dazzle (*l.* twins, triplet: |*Se-Aoa, in pl.* lungs|, consumption); *.n* offend each other (*m..* olive tree); *.-eh* be scandalized (*s-O* face); *-ol* remove trouble from eye or heart, .crush grain on mill, *ho re.* add little more water in pot. ..rain slightly. *.hanya* hold several spears, sticks. *.ts* speak badly to D, but E weep, stamp half-ripe corn, wet half-ground do. *-ohets* bless by rubbing with *seboko*, e.g., with lion's skin, in the case of the lion clan. *-oloh* to get open ears, eyes; *-oll* unstop, open.

fákà, to set in (*s-O* hail?)

fála scrape (*s.* unburnt big corn pot made of mud and mist, *s.bohOhO* Venus), *l-i* erasion, *s-i* scraper (of ox hide), *s-o* iron scraper: also *phako. fatsa* ache (*l.* splinter, *cf. mofacha* a scar), *.n .tsa* exterminate, pour out blood, by flux, or abortion in 1st month.

fàlá threaten (*l.* i.q. X *iphala* vagabond).

The following are observations I venture to make, in supplement to the Mabille-Dieterlen dictionary, and largely suggested by Endemann:—

falimcha, watch (N. blink)? connected with *fála*.*

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* Other derivatives *l-oa* a bird, *-imeh* watch (N. blink), *-ol* be loud (of a horn). To the glee of the French missionaries in Basutoland, Meinhof has translated *letSoala* barbel *as Barbier*, and derived from *fala* by his rules of phonetic change. I venture to think, however, that the word is really so connected, the 'antennæ,' from which the fish takes its name, *scraping* the ooze as truly as a barber does the face. If so, the German scholar's philology was better than his eyesight, and the quaint mistake, while shewing ignorance of the particular idiom, would testify to the sureness of his philological system.

fámola (cp. *ph* . . . blurt) spread nostrils, which *-oh* (go out on both sides).

fánya, perceive amiss; . . hesitate D. Some see a connection with the previous word, for the sense organs have to make *effort* when their work is difficult. But *-eh* is Z. *phanyekha* hang (-loose, phaphama). *Ph* . . . is to roam or overflow D, cp. *phenya* seek everywhere.

fàpa wind something round (*m.hloho,* head band, crown; *m-o* splice, D; *s-O* rings, binding, cp. *leràpo*): *.n* recipr. quarrel, be cross (*s- - o* is the Cross); *-oh* go out, lose way, (*b.* where one leaves the road E); *ol* unwind, neut, *-olh.*

fàphá, praise, *cp.* (*pha*)*2tha* caress. But *lefáphà,* a quarter of a town.

fára, hold child in lap (*l.s,* sprig of corn, crooked thing, *e.g.,* horn D; *l-u* cleft, and *so pharu* D, *s-o* groin or fork of tree E), cp. *ph* . . . (*.m* & *.ll* also squat) . . appear from several directions at once; *.s* be dispersed D.

fàta hollow out (*s. s-E* nek E, *m-e* ox killed for hunger; but *lefátà* digging-stick, and *s-E* tree, cp. *-ol* split off, and *fátsa* chip, *m.* spike in game-pit.

leFatla 'Baldhead' (the compiler's native name), b. baldness, s. forehead, are connected with Z. *phandla* expose.

fa-tSe, though now used with prefix *l.,* is really an adverbial phrase "on-ground," and certainly will not translate "world" (as in the Suto Nicene Creed), which is, of course, *aeon,* *O.E wer-eld* i.e. *man-age.*

fìhla, arrive but *!* hide. But *l.* eunuch is from *fihihla* rub in pieces.

fína, knot (*s-e* young calabash, used for a bottle E); *-yel* ripen, or sit sideways on the ground. *fi.* press out udder.

fófa fly (*l-E* "flutterer," red-breast; but *s-i* quick mover), *?-onel* smell. D has the same word for "become weak" (but Ef*Ofa*) and *-or* shake off dust (*l.* .crumbs), etc. *-oth* is to grope (*l - - o* dark, cp. *s-u* blind, whence *fou*fala, etc.). Is -o lukewarm connected?

fohla, strip (*l-o* bit of booty, *m-o-o* much do, but *l.* with broad *O* dry, barren cow) *-el* build with poles. But *-ots* is Z. *phuhluza* strike hard, so Suto *.k.*

fóhola, skim D (*s-e* beam or cord to hang on).

fóka, sprinkle, *e.g.* of witchdoctor, blow (s. fan, *m.* tare, but *l.* very tall grass; *l-i* loose sand), cp. (*fokho*)*2 fokhotsa* throw up much earth or water D, but E says *ho re f* . . . is to be weak, e.g. of earth. I have no light to throw. *.el* is to sway in walk. *-Ol* is to be weak (so I with E against D). *-ol* (*m- - i* weakling, *l- i -* hemlock, *l- - oli* millipede, *m- -o* or *foko* weakness).

Distinguish *fóla* eat (but graze is *fula*: *b-o* meadow, *ph.* vale, pasture) whence (*l-o-o* business, cp. *pola* thresh, and our idiom "threshing out"), and *fOla* get cool or well (*l-i* pumpkin), whence ? *-el* string (beads), *-ol* un-string, *-ots*

miscarry (*s..na* still-born) and ? (*fOla*)2 listen N. (*phOfÓLO* is a soft-footed beast,. cp. *sefou(a)* dumb man): and further *fula* shoot with bow.

foma; fonoka, -sets, -thets; fopha: v.D.

Distinguish again *fÓra* plait (*l—O* tuft) cp. *phOtha* (? *lephoto* = *lenaka* horn) and ? *-ol* (with shut *o's* D) screw out, e.g., tooth, with *fora* graze well, E *fòra* deceive, D *fotha* steal (*l..* thief, *l--o* cooked maize, *m--ela* hurried beer), *--ol* pluck, *ho re* (*fotho*)2 root out, *s..* herb mixed with snuff.

? cp. *fOrOla* rub off, so *ph...* (and with *th* for *r*) E, and *i..* purify oneself after a death D.

fósa miss (*b-i* error, *b-O* misunderstanding) e.g., giving milk, of cow.

fótela D add, E encircle (*s-o* armband).

fuama D.

fuba, be red (*-elu*), prob. orig. *KUVA* breathe (*s.breast, l.* asthma), so blush (*ma-e* dawn).

fufa (*l.* jealousy), *-ehel* of the woman. *-ul* transpire, sputter (*lefilo* milk-froth, *sefuli* water fowl, *lefúla* flood, *mofufutso* sweat), cp. *-umets.*

fukha, etc. D. *-utla* dig, eat greedily.

Distinguish *fuma* be faulty D, and have riches! (*l-O*, contrast *l. b.* poverty!) from *fúma* strip off fibre. *.u* find, *--eh* be poor through *circumstances.*

(*funya*)2 work in hurry. Perhaps pull oneself together, N. *shuma* means knip ? *cp.* Xosa *funa* seek, Suto *runa* hunt lice!

fupa, purse lips (*l-u* corn heap, cp. *phúpu* antheap D), *-uh* bloom (*-us*): *.r* clench, etc. *-utl* seek; also *-uts.*

fúra (*-utla*) hollow out (*b-e* backyard): *.ll* turn the back upon forsake.

fúsa, of slight lightning stroke, Z. catch.

futa (*ka*) put in mouth at once, ? *.han, .m*: *-uh* go out to fight.

futha blow (*m-u, b-u* heat, *bor...O* lukewarmness, *m-O* billows, *s-o* forge), *-umal* have heat (*b--o, m-umela*).

futla, halt! .m sit down, fall.

futsa, resemble X. *fuza* (*s-i* hip bone): ..very poor man, so *m. na;* cp. *.neh* become such); *-oll* undo, e.g. thatch, from Z. *fuzula,* real Suto cognate *rutlolla.* *-oel* mix pap with milk, etc. (*m--o*).

A more careful investigation of the tones, and of the dialectical meaning of similar words, would probably clear up the etymologies and decide whether or not they are connected. The completion, however, of such a work takes a very long time, and I thought it better to submit my notes, so far as they have gone, at present.

It will be observed that all clicked words, as non-Bantu, are omitted, as also words from English and Dutch.

THE PHILOSOPHICAL LIMITS OF SCIENCE.

By Rev. Sidney Read Welch, B.A., D.D., Ph.D.

The word "science" is used here in the popular sense of knowledge that can be verified by tangible proof.

In a wider sense philosophy is also science; and this is admitted by the usage of some scientific societies and periodicals. Without debating about names we may say, that both science and philosophy are knowledge; and by knowledge I mean a psychical state in which somehow the nature of objective reality is conveyed to our minds.

Some scientists deny that philosophy can really solve any problem; and that its efforts to deal with ultimate causes have been a vain and unprofitable undertaking. These may be counterbalanced, and to use a parliamentary phrase "paired" by the extreme left wing of philosophers, who hold that all scientific knowledge is tentative and uncertain; that even mathematics is based on a few shaky conventions; and that no amount of present consensus, on the part of scientists, can go bail for the future teaching of science.

But to-day the large body of both scientists and philosophers agree in thinking that both science and philosophy have contributed in various ways to the sum of human knowledge.

Philosophy may roughly be taken to include the conclusions that deal with the principles and processes common to all sound knowledge. Aristotle believed that in his day the level of pure thought had reached its high-water mark in Socrates, who accustomed men to express general conceptions in definitions arrived at partly by analogy and partly by induction.

To-day, after many changes of fashion, logic, metaphysics and portions of modern psychology may be said, together, to constitute the realm of philosophy. They provide the body of general principles that act as a useful corrective and restraint on the particular work of all the sciences.

It is in this sense that I propose to speak of the philosophical limits of science. For the whole of purely human knowledge is not so much the sum of philosophy and science, as their product. They interpenetrate one another completely, and are not mere results that exist side by side.

Hence if we choose to represent the results of science up to date, as a complex quantity within brackets, we may represent philosophy as an x outside the bracket. Upon the value of x will depend the value of the whole, and thus the value of x limits the total. Thus philosophical speculation on the assumptions of science may be said to limit and qualify the human value of the whole wealth of scientific attainment.

I do not lose sight of the fact that the action of philosophy and science is mutual. Science, by its assured results, has restrained many of the vagaries of philosophy. But that is not my theme at present. I am looking at the boundaries between philosophy and science from the other side of the fence.

The first limit of science on the philosophical side is to be found in metaphysics. This tests all the underlying assumptions of science. No science can, by its own methods, assure us of the value of its own postulates. Even the axioms of Whitehead and Russell's *Principia* are amenable to further analysis by the metaphysician.

This analysis has sometimes been extravagant, as was the case with Le Roy, the mathematician, physicist and metaphysician. He contended that the foundations of science were too shaky to admit of assured knowledge. All that we could arrive at is a number of useful rules for the guidance of life. Given human life on this planet the so-called laws of nature were useful conventions to be noted. For the intellect distorts all that it touches. In his system our x comes perilously near to zero.

Yet the sense-data, the particles, points and instants, which are taken for granted by the mathematician and the physicist, need to be explained in some coherent way, if science is not to be built upon sand. The ideas which they suggest are full of apparent contradictions and intellectual difficulties, which are outside the purview of pure science.

Then take the belief that buoys up many scientists, and is a fundamental principle with them in practice: that the laws of nature are fixed and so discoverable. The idea occurs spontaneously to most investigators, who deal habitually with natural phenomena. They become impressed with their recurrence according to law. But if this idea is anything more than an instinct, there must be some explanation of the wild paradoxes which it seems to entail.

My point is that whatever view we take of these fundamental facts and principles, and of others like them, becomes a system (more or less ample) of metaphysics, which must influence and to some extent limit our knowledge. In this way science becomes something more interesting and informative than a game of chess.

Logic is another branch of philosophy whose restraining influence is, or ought to be felt in every department of science. If it did nothing else but clear the ground of a great deal of rubbish, its effect would be beneficial. Its claims are in no danger of being denied to-day; for there is a school of thinkers who would reduce all philosophy to logic.

At any rate, it analyses and valuates the intellectual tools of science, the mental processes by which science is conducted. In so doing it shows the limitations of these tools.

Induction, for example, is often called the "new organ" of scientific results. But how can its scope and validity be justified? What are the conditions of its valid exercise? On these points there has been a bewildering discussion among the logicians. It may be said that logic itself is discredited when it gives a hesitating verdict about the value of processes that the average man uses without hesitation. Types of logical theory

may be discredited in this way, if they are over fastidious in dealing with plain facts. But the remoter applications of induction are not plain facts, nor is the process on which they are based clear. It certainly impresses one with the limitations of the mental instrument that science is compelled to use.

And in the history of science we have many instances of the pitfalls that the over-confident meet in the use of induction. There is the enormous structure of inferences that have been built upon the skulls of some pre-historic men. We had the N rays which shone brightly enough in some scientific treatises for a year or so, and then went out. There are the many atomic theories and those about the ether. Logic marks clearly the limits between hypothesis and law or fact, and limits the results of research accordingly.

Philosophy also creates a habit of mind, which helps to correct and so to limit the effects of specialization, which is one of the intellectual dangers of scientific practice. There is a body of systematized common-sense, which is the outcome of the best philosophical speculation. This forms a check on the habits engendered by the specialist work in confined areas of research.

Evolutionism is a case in point. It may be defined as the endeavour to extend to the whole universe in all its parts the law of evolution, which has been discovered to obtain in certain departments of biology.

For a generation or two, evolutionism was the received opinion among scientists, and it had become almost a dogmatic tradition. The law of evolution has been found a useful formula to explain and illustrate many processes in future, not formerly well understood. But evolutionism, when analysed by later scientists in the light of general knowledge, has seemed to many a rather hasty generalization from some special ascertained facts.

Philosophy is capable of performing another useful function in delineating the frontiers of the various sciences. As the frontiers are changing pretty constantly, this work is ever being done anew. New maps of the scientific territory are usefully drawn from time to time.

The history of these classifications is also a history of the encroachments of one science upon the ground of another or of others. Philosophy devises a kind of law of nations, not quite as elastic as its prototype, yet variable enough, and taking account of the general advance of knowledge.

At the end of last century biology furnished a notable example of the need of these delimitations. There was a tendency to push its methods into physics, the social sciences and even psychology. A fair number of scientists seemed inclined to return to the position of the sixteenth-century philosopher Cadran, who said: "not only do the stones live, but they fall ill, grow old and die."

As a reaction against all this, there was a cry that science had become bankrupt. That was a philosophical exaggeration. The credit of science was never, in fact, better. Some scientists and especially biologists, had made promises and prophecies that had signally failed. It was only their vain hopes that had collapsed, because they had given their science too much credit.

The movement culminated in about 1905; and the result was to define more clearly the limits of biology. By helping to keep it within its natural boundaries, philosophical discussion had rendered it a distinct service. A French biologist (Grasset, *Les Limites de la Biologie* p. 179) writing as a philosopher, maintains that philosophic liberalism consists in saying to all sciences: "Do not issue from your natural limits, and your domain will be respected. Do not encroach and you will not be invaded."

Finally, philosophy establishes the existence of other planes of thought, useful or pleasant, where scientific processes alone are insufficient. Some of these may be called higher planes, some lower, and some collateral. There are literature, for example, economics, theology, and ethics. To deal with these topics only by the scientific method would be to destroy them.

In the case of ethics the resultant evils and falsity have been brought rather sadly before us through the War. Science, unlimited by ethical considerations, does not make for truth or happiness or the common welfare. In literature we may instance Zola, who was touched by the ultra-scientific desire for method. What he has done best is the inspiration of his art; the worst is partly the result of a wooden effort to subordinate literature to science.

There are important branches of our mental activity which have their own methods, entirely different from those of experimental science. But they are the only valid way in these spheres; and it would be illiberal to hold that they are not methods of knowledge, because they are not the ways of natural science.

These considerations will help, I hope, to set forth some of the reasons for mutual respect between philosophy and science.

Each has threatened to absorb the other at different times. The extreme philosophic view is that which claims all reality to be mind. The extreme scientific view excludes all but matter from the realm of the real. The attitude of scientific despair gives it all up as hopelessly insoluble.

The human attitude would seem to consist in recognising these two realities, and in endeavouring to delimit their boundaries.

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THE WIT AND WISDOM OF THE BANTU AS ILLUSTRATED IN THEIR PROVERBIAL SAYINGS.

By James McLaren, M.A.

By the Bantu we mean the numerous and virile dark race which forms, perhaps, 99 percent. of the native population of South and Central Africa, from the Cape of Good Hope to 5° North of the equator. They number in round figures about 100 millions, and speak nearly 200 languages, besides dialects; but all these languages have an essentially similar structure, and show a close family likeness to one another.

The forms to which Bantu literature was mainly confined until recently were those of the folk-tale or fable, the praise-song or eulogy, and the problem or maxim. To these have been added recently, among the tribes which have come into closest contact with Europeans, translations, newspaper compositions, mostly of an ephemeral character, and tentative efforts at the writing of short stories and poems.

The neglect of Bantu literature in the past has been almost absolute. The farmers were too much occupied with the constant struggle against famine and flood and the numerous diseases that affect stock in a warm climate, or against the aborigines themselves, to give much attention to their literature, even when they could speak their language. The commercial and mining classes were too busy gathering the gold and diamonds in which Africa is so prolific to look for the nuggets of thought which have been concentrating through the centuries or the sparkling gems that have been struck out in the eloquence of some native orator, and have been treasured up in the memory of succeeding generations. It has been left to a missionary here and there, or a teacher in some missionary institute, or a Government official with literary tastes, to make some effort to collect and exhibit them.

In work of this kind men of German race have in recent years taken the preponderating part. Bleek, Kropf, Seidel, Endemann, Meinhof are leading names. Now that the activities of the Germans in Africa are curtailed to a large extent, whether temporarily or permanently, there is all the more need for other workers to bestir themselves in the study of these numerous languages, and in the collection and recording and translation of that literature which throws almost the only light that is available on the history of the southern half of the Dark Continent in bygone ages. The opportunity is rapidly passing. It is a remarkable and a disquieting fact that there should be chairs of Bantu, or at least African, languages, in Hamburg and Berlin, and none in Britain or British Africa. Africa is 80 years behind Asia in the study of its languages and literature; in other words, as much was known of the languages of India in 1837 as is known of African languages to-day. The only way to deal with the matter is by the foundation of a Chair of Bantu Languages and Literature, equipped with adequate resources for purposes of research, somewhere in the Union; and, in view of the location of the invaluable

Grey Collection in the South African Library, preferably in Capetown.

In dealing with the very extensive subject that I have named, I shall confine myself to proverbs selected from the four Bantu languages chiefly spoken in the Union, namely, the Sechuana and Sesuto of the centre, and the Zulu and Kaffir of the East. I prefer the name Kaffir to Xōsa, because the word Xōsa is invariably mispronounced in every single letter by people who do not speak the language, because the Xōsa tribe forms only one-fourth of the people who speak the language, and because Kaffir corresponds to Kaffraria, the well-known designation of the district in which the Kaffirs mainly reside.

A few Kaffir proverbs were long ago collected by Dr. Theal and embodied in his "Kaffir Folk-lore." The first edition of Dr. Kropf's "Kaffir Dictionary" contained nearly 200. These were brought together by Mr. Bud'Mbelle in his "Kaffir Scholar's Companion." Dr. Rubusana, in his valuable compendium of Kaffir literature, "Zemk' Inkomo Magwalandini," gives a hundred, mostly new, with detailed explanation of a few of them. Bryant's "Zulu-English Dictionary" contains 200 or 300 proverbs with translations and English parallels. The Rev. E. Jacottet, in his "Contes des Bassoutos," gives about 60 Sesuto proverbs with their equivalents in French, and several more are to be found in Mabille's "Sesuto Vocabulary," and in Miss Martin's "Basuto Folk-lore." Jacottet refers to a collection of a thousand Sesuto proverbs which had been made by a native teacher, Azarias Sekese, and published at Morija, but without translation. A translation will no doubt appear when the "Treasury of Basuto Lore" is continued, as continued it must be, in the interests of many branches of science. Finally, Mr. Solomon Plaatje, editor of a Sechuana paper, has brought out a large and most valuable collection of "Sechuana Proverbs," with translation into English, and parallels in half-a-dozen European languages.

"A proverb," says Chambers, "is a short familiar saying expressing a familiar truth." "A proverb," says Murray, "is a short pithy saying in general use." According to Cervantes, "proverbs are short sentences founded on long experience."

The proverb should be short; it should be pithy, like the egg in the Scotch conundrum: "A wee, wee hoose, and it's a' fu' o' meat." It should be striking in form, so as to be easily remembered. It usually consists of two balanced members; and alliteration or rhyme or some other similarity in sound is a very common feature. It should strike the intelligence by its truth as much as the ear by its sound. It is a bit of concentrated thought on some aspect of life, a crystallized opinion, a gem from the mine of human experience.

It is only quite recently that the importance of a consideration of popular proverbs and maxims in their bearing on the study of the sciences of psychology and ethics has been pointed out. In Dr. Alexander F. Shand's recent book, "The Founda-

tions of Character," probably the most important contribution to ethical science made for many years, he bases his results largely on the wisdom of the people as expressed in their literature, and comments strongly on the neglect by philosophers hitherto of the wisdom of life embodied in popular fables, maxims, and proverbs. There is little doubt that the shortest route to a knowledge of the Bantu psychology and the Bantu ethics is through the study of their proverbs on the one hand, and their folklore and fables on the other.

What most strikes one on glancing at a collection of these proverbs is how human the Bantu peoples are! There is an immense difference between the Bantu in their native state and ourselves in colour, features, food, houses, habits and institutions, but a quite wonderful similarity in judgments and conclusions, ideas and opinions, on life and death, youth and age, and the various instincts, emotions, sentiments, desires and aims by which man is affected or swayed, as well as on the qualities which determine his success or failure in life. They commend the same virtues, urge to the same efforts, stigmatize the same vices, and satirize the same follies that our European proverbs do.

Government by phrases or formulæ, so prominent nowadays, is as old as time immemorial with the Bantu. After the subject has been laid down, understood and discussed, the "word," the "phrase," that will best sum up the opinion of the assembly is sought, and is usually found in some analogy with animate or inanimate nature, of which the native people are close observers, then stated by the chief or the spokesman of the assembly, and the matter is settled.

For convenience of treatment, I have arranged the proverbs into groups dealing with allied subjects, as Man and Woman, Parent and Child, Hunger and Hospitality, Wisdom and Folly, Life and Death, and so on.*

On Man and Woman.

There are two words for man in Kaffir, *indoda* and *umntu*; man as the male or husband, and man as the human being. The word *Bantu* is the plural of the latter, and means just human beings. And the word for virtue in the Bantu languages is *ubuntu*, just manliness, all that becomes a man. So the Zulu says: *Ngitanda umuntu onguumuntu*, I like a man who is a man (a man who is manly); we came to men who were not men (to human beings who were not humane). The word for character is *isimilo*, what one has grown to, or *isitunzi*, the shadow one casts. *Akanasimilo*, he has no growth, they say; or *akanasitunzi*, he has no shadow, by which they mean, he has no character, no standing, no self-respect. *Uyazihluba isitunzi ngokwenza njalo*, you are stripping off your shadow by doing that, they say (you are losing your good name). One without character is *ilishwa*

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* Most of the Kaffir and Zulu proverbs are given in the original as well as in translation; the Sesuto and Sechuana proverbs in translation only.

lomhluzi wamanqina, a misfortune to the shank-soup—a dish greatly prized—(he is a disgrace to the family). On the other hand, *ndisaya kuba ngumntu*, I shall still be a man, is uttered with deep feeling by one who is recovering health after severe illness or status after a fall, or happiness—as through a second marriage—after bereavement.

And what of Woman? You can't eat the eyes of a woman as you can those of an ox ("Beauty is skin-deep"). Not her face but her heart is comely ("She's better than she's bonny"). A woman is a mimosa tree that yields gum all day long, say the Kaffirs, who are as fond of chewing-gum as the Yankees. The real home is the women's courtyard ("The hand that rocks the cradle rules the world"). He has not married a woman—she is a man, is the highest possible commendation. Then the other side: "A man's Yes is Yes, but a woman's Yes is often No." *Ziyal' abantu, ziye ebantwini*, they refuse people, yet they go to people (Though they jilt one they will wed another; there are few old maids in Kaffirland). Women's gossip breeds civil wars, they say; or a woman will set kraals a-quarrelling ("*Cherchez la femme*"). You know the great ground hornbill or bromvogel that stalks across the veld in the Eastern Districts (looking for rain, the natives say). Well, the female bird, according to the Zulus, says, in a high, piping voice: *ngiyamuka, ngiyamuka, ngiya kwabetu* ("I am going off, I am going off, I am going to my people"). "*Hamba, hamba*," responds the male in a deep bass, *kade usitsho* ("Go then, go then; you have been saying that for a long time").

Of love they have not much to say. Marriages with them are, or used to be, mainly marriages for convenience, and were arranged mostly by parents and guardians. Of lovers, friends, or things that are inseparable, they say: *ngumti nexolo*, it's the tree and the bark; *lugwayi nentlaba*, it's the tobacco and the aloes (which were always mixed to make snuff); *ngumtya netunga*, it's the riem and the pail (the riem for tying the cow's legs and the pail for milking her into). *Akusoka lingenasici*, there is no suitor without some defect; *akungeze lingenasiyiko*, there is no handsomest fellow without some blemish, they say; but they say also: there is no raven so bad but some would love it. *Ingwe idla ngamabala ayo*, the leopard shows off by its spots ("Look your best when you go a-courting"). The bridegroom's bottle goes round freely (courtship is an expensive business). The monkey's son-in-law eats what the monkey eats (It is well to keep in with the old folk). Happy is she who has a daughter, for a boy is the son of his mother-in-law—

> "My son is my son till he get him a wife;
> My daughter's my daughter all the days of her life."

On Parent and Child.

Ukwanda kwaliwa ngumtakati, family increase is forbidden by the wizard, is said by way of compliment to the father of a

fine, large, healthy family—there has evidently been no wizard about here. (There are no silly, selfish decadents and no empty cradles in Kaffirland.) They have many sayings illustrating the resemblances due to heredity: *Umvundla usek' indlela*, the hare keeps to the path the old hare made ("Like father, like son"). *Wamfuza, kashiya nacuba*, he resembled his father to the last leaf—*i.e.*, in every single feature. *Lihluma esiqwini ikikizela*, the shoot grows from the old stock. *Injalo yapuma edunjini*, its like came out of the Kaffir-potato ("He's a chip of the old block"). *Izinkonyana zilandela onina*, the calves go after (*i.e.*, take after) their mothers. *Walandela umntwana amabeka*, the child went after the dowry cattle (*i.e.*, took after its mother's side of the house, to which the dowry cattle went). They have not failed to notice that acquired characters are not always transmitted. The good milker does not reproduce herself (The daughter is very unlike her fine mother). *Umtati wazal' umlota*, the sneezewood begat only ashes (A worthy father has often a worthless son). The Bantu are affectionate, even indulgent, parents, but discipline must be maintained: *Uya kukolwa yeyokwosa, eyokupeka ungakayidli*, you will be content with the roast meat, you won't wait for the boiled, is a warning to a naughty boy. Another is: *ukuhlwa kuya kukubuta*, the dusk will rake you in; or, *wolibamba, lingatshoni*; catch it (the sun)—don't let it go down (When the darkness comes on you'll have to come home, and you'll catch it—in another sense—then).

On Self and Others.

Egotism is a human characteristic that is by no means unknown among the Bantu, and it is mercilessly satirized by citing instances of its like in the meanest creatures. "I and my rhinoceros," said the tick-bird, according to the Basuto (*Ego et rex meus*, said Cardinal Wolsey). "The monkey does not see the bump on its own forehead," says one tribe; "The monkey does not see its own hollow cheeks," says another. There is no little coney but boasts itself. Even the field-mouse thinks itself great. There is no wild beast but roars in its own den. Even the civet-cat—the little black-and-white striped muishond—roars at its own hole. ("Every cock," as we say, "crows on its own dunghill.") *Akuko ndlovu isindwa ngumboko wayo*, no elephant feels the weight of its own trunk. *Akuko qaqa liziv' ukunuka*, no civet feels its own bad smell. (No one admits his own failure or is conscious of his own defects.) There is no commoner object by the side of every stream you cross in Kaffirland than the comical-looking paddavanger or hammerhead, which the Kaffirs call *Qimngqoshe*, and the Zulus *Tekwane*. Well, the Tekwane, looking into the river as it always does, and pluming its feathers, says to itself, according to the Zulus, *Ngangimuhle, Tekwane, ngoniwa yiloku naloku*, "I, Tekwane, would be quite nice-looking if I weren't spoiled by this and by that."

And how ready we are to excuse ourselves: *Ukuzenza akunjengakwenziwa*, doing it to oneself is not like having it

done to one. Or: Our ulcers don't hurt when it is ourselves that rub them. How ready we are to do ourselves more than justice: *Ukuzisikela enqateni*, to cut off for ourselves from the fat part; and to think that all our geese are swans: When a man speaks of good milkers you may be sure he means his own goats.

Of others they have not much to say, but they appreciate friendship: A ring makes a sound when it strikes another ("As iron sharpeneth iron, so a man sharpeneth the face of his friend"). It is good to grow at the toes (It is well to have many friends, by whose support one grows or prospers). One born without blood-relatives is no better than a heap of meat (on the battle-field, that is, for he has none to rescue him as others have when the enemy presses hard). Strangers surprise each other, they say ("When Greek meets Greek, then comes the tug-of-war"). And when one is found to be favouring strangers at the expense of relatives, they say: *Uzipembel' emoyeni*, You are kindling your fire in the wind (instead of on the hearth; much good it will do you there!).

On Hunger and Hospitality.

Hunger has an inconvenient way of forcing itself on the attention of poor people that the Bantu have not failed to comment on: The hand never loses its way to the mouth (Hunger asserts its claims). *Usegolela impukane*, he is snatching at a fly already (he is so hungry). *Andikange ndosule umlomo wam namhla-nje*, I have never wiped my mouth to-day (*i.e.*, never tasted a mouthful of food). *Isisu somhambi kasingakanani, singapambili kodwa*, a traveller's stomach is not so big, but it is in front (and therefore important and clamorous). Hence the sacredness of hospitality: *Unyawo alunampumlo, alunamehlo, luyimpumpute-nje, luya kukutwala lapo ungazani nomntu*, the foot has no nose, it has no eyes, it is only a blind thing groping its way; it will carry you where you know nobody (Don't be inhospitable; your steps will bring you some day among strangers, where you will be glad of hospitality; they may even bring you to the place of the very man who now asks hospitality of you). Of the churl they say: *Ndafika kwanja-yot' umlilo*, I came to the place of Dog-warming-himself-at-the-Fire.

Of Greed and Giving and Gratitude.

Unomkala, he has a throat, means he is very greedy. *Uyavuza amate*, he leaks saliva (his mouth waters like a dog's in prospect of a meal). *Kuxeliwe e-Xukwane*, they have slaughtered at Xukwane, you'll get big helpings there, is said of one asking too much. "Give me! give me!" only makes hungrier (The beggar's wallet never gets filled). You'll drain the fountain (You'll kill the goose that lays the golden eggs).

Ikaba abayisengayo, the cow kicks its milkers (The beggar has to bear many a rebuff). *Uxam wapusile*, the leguaan or monitor (which is said to be a most affectionate nurse to its young) has gone dry (You have outstayed your welcome).

Lukwekwe lwexwili, he is the scab of a wild dog. (He is an incorrigible beggar.

Ukupa kuzibekela, giving is laying by (or, as Scripture has it: "There is that scattereth and yet increaseth"). Give-an-Ox is not a fool (A gift appeaseth wrath). The ox stops the assegai (The vanquished chief sends an ox to the victor, and thereupon peace is concluded). *Ububele bufun' obunye*, a kindness wants another one ("One good turn deserves another").

If liberality is thus commended, meanness is bitterly satirized: *Kokwabanye nwayi-nwayi, kokwako roqo*, for another's you itch, itch, as regards your own you draw in your hand. Giving is fair play, being stingy is making yourself notorious. The mouth that does not eat puts by for that which does. If you are too smart to pay the doctor, you had better be too smart to get sick. *Kancitshani! ubopa inja nezinkuni*, just think! he is so stingy that he ties his dog to the firewood (lest it should snatch a scrap).

Gratitude has been defined as an acknowledgment of past favours and a lively sense of favours yet to come. All this and more is pithily expressed in what is perhaps the best-known of all the Kaffir sayings: *Ungadinwa nangomso*, don't be tired even to-morrow. The natural gratitude of the native for the smallest favours is indicated by the way in which he receives your donation or reward, even if it is only the ubiquitous tickey, namely, by holding up both hands to take it. "You have taken the wedge from between my teeth," means: "You have relieved me from great embarrassment." Ingratitude is condemned in sayings like these: The dog I brought up now bites me. *Musa ukupa izintselwa njenja-Batwa*, Dont pull up the gourds like the Bushmen (after drinking out of the calabashes: *i.e.*, don't speak ill of a benefactor). Thanks are not rendered to those who can hear them (We often remember our indebtedness too late).

On Hatred and its Associates.

Of Hatred and its associates, Anger, Envy, Malice, Cruelty, Jealousy, the Bantu speak in many proverbs: *Inyosi zinobusi*, the bees have honey, they say, when one flies suddenly into a passion; the bees have honey, and so are easily excited. *Ngalutinta ukuni lombangandlala*, I touched a log of the flare-up tree, is said of a very irritable person. Of an angry man they say: *Usibekele*, He is overcast, like the sky on a cloudy day; or, He has got his mane up (He is bristling with wrath). *Induku itshaya imvliki*, the stick hits the warder off, indicates that resistance increases anger. *Ukumtshisela ibudle*, to burn the porridge-stick for him, is to make it very unpleasant for one. *Ukubeka umntu nenyoka*, to look at a man as at a snake, is to look at him with deadly hatred. "They beat each other with a live snake" means that they are at daggers drawn. *Tambo lenyoka, hlab omzondayo, lihlaba libolile*, bone of a snake, stab him whom thou hatest, stab though rotten, is a deadly curse. *Impi yakwa-Mabonwa-bulawe*, it is the army of Kill-him-at-Sight, is an expres-

sion of mortal enmity. Enmity is also expressed by sayings like: "They (the cattle) don't eat on the same ridge," or "They don't take fire from each other's hearths" (as people were glad to do before the coming of lucifer matches). *Ubodl' esambesa*, he loathes while he clothes, indicates outward friendliness but inward hate. The proverb for cruelty is: *Ixama litolwe nga-Batwa*, the hartebeest has been arrowed by the Bushmen (*i.e.*, the man has fallen into cruel, merciless hands). Cruelty to animals is discouraged by the words that a child must say if he has killed a frog: *Mkoni wam, ungati . . . woti . . . ..."* Frog of mine, don't do so" (drawing in the arm), "do so" (stretching it out). If he doesn't say so, his arm will shrivel up, so he is told.

Feuds were kept up in Africa in old days as long and as bitterly as in Europe: Though a snake is dead, a bone of it will pierce a man to death, is said of the recrudescence of an old feud. *Umlandu ubanjwa yinkume*, the quarrel is taken up by the centipede (which comes out of the old log when struck, *i.e.*, the father's feud is taken up by the son). Family quarrels are reprobated: *Umbango uvut' emloteni*, the strife blazes up in the family ash-pit. *Induku ayinamzi*, the stick has no kraal (Where there is constant quarrelling at home, no family flourishes).

Of malice they say: *Ulunya lubiz' olunye*, a malicious act calls for another (Malice begets malice). Of envy: He who gets rich late has a hard hill to climb (The upstart has great envy to surmount). *Umona wasemlungwini ubandez' icitywa, ungaliqabi*, the white man's envy forbids us the red clay, though he doesn't paint himself. Of jealousy: Jealousy was cooked in a pot with a stone; the stone got soft, but jealousy remained hard.

Anger and hatred may often be avoided if warning is taken in time, and the Bantu have many proverbs expressive of threat and warning: *Ukasel' eziko*, you are creeping to the fireplace (You are going into danger). *Udlala ngegeja kuzilwa*, you are playing with the hoe on a fast-day (You are doing what is forbidden and dangerous). *Uya kuwa into embi eyawiwa ngu-Hili wasemabalini*, You will get what Hili of the fables got (Hili of the fables was always playing tricks on people, but he came to a bad end). You are going to tread on my tail, and the fur will come off, reminds us of a well-known Irish saying. *Wod' ufunyanwe, sesimatonts, abanzi.* You will be caught in the storm; big drops are falling already. And sternest of all: *Ikanjana lake lingakelwa ongoso ngelanga*, the field-mice may be building in his little skull ere long (I'll do for him if he doesn't take care).

On Crime and Punishment.

The thief is the one that is caught, say the Kaffirs. Caught in the act, say we. They are very fond of casting the blame of their ill-deed on others: He hid himself behind me, they say. The thief has splashed the other man's face with the milk, is said of one trying to transfer guilt from himself. *Intsimba isulele ngeqgumusha*, the genet wiped itself off on the bush

skrike (its neighbour in the thicket). Or: "Am I your door-mat, then, to have the mud always wiped off on me?"

But justice is usually done: *Uxamu ubamb' udwala,* the leguaan clings to the bare rock (The man is plainly guilty; he hasn't a leg to stand on). Let the harts of the summer heat pant facing each other (Confront the accuser and the accused; let us hear both sides and then judge). And punishment follows crime with fair certainty: A crime does not rot, they say ("Murder will out"). The trap catches even when covered with cobwebs (Vengeance comes at last). The brand returns to its kindler ("He is hoist with his own petard"). *Okwamuva kudlul' okwamandulo,* the retribution transcends the injury. Of a richly deserved castigation we say, "I'll beat you, and I don't care who sees me," but the Zulu goes one better and says: *Ngiya kukushaya, ngibuye ngiocela ugwayi kuyihlo,* "I shall strike you, and then go and ask a pinch of snuff from your father." The Bantu opinion in regard to the respective liability of employer and agent is shown in these two sayings: "A messenger has no fault," and, "If you are sent to insult the King (*i.e.,* the big chief), do so" (It is the sender who is responsible).

On Power and Possession.

As the last section has brought us to the chief and his courtyard, let us see what the Bantu have to say about Power and Possession. The sayings indicate an autocratic rather than a democratic rule: *Uma inkosi ikuluma amadoda atulise indlebe,* if the chief speaks, the people make silent their ears. When the chief has promised you a beast, you can build yourself a kraal (the smile of the great). *Isitukutuku senja sipelel' oboyeni,* the sweat of a dog ends in its hair (The poor man must swallow his wrath: the frown of the great). *Lidume ladla umunga,* it thundered, and the lightning struck a mimosa tree (The chief killed a man in his wrath: the mimosa, being resinous, is peculiarly liable to be struck by lightning). *Ibizelo ladla ikondekazi,* the summons killed the she-baboon (A summons to the Great Place too often means death). *Umzungulu ubopa womile,* the monkey-rope ties fast though dry (A man may still be powerful, though old and wizened). *Deda, mhlangela, endaweni yenywagi,* mungoose, get out of the way of the genet (Make way for your betters). There is not room for two bulls in one kraal, they say; or: An ox doesn't kick in two kraals (A chief may be great in his own tribe, but have no authority elsewhere).

About possession they say: We eat with the possessor of the knife, we give nothing to the cook. *Ohlab' eyake kalelwa,* who slaughters his own is not forbidden (A man can do what he likes with his own). *Kubangwa umtulwa nemamba yini?* Does one contend for a medlar with a mamba? (Have you the audacity to claim what I hold?). *Ongena siqepu sentlabati uya kuhlafuna egijima,* he who hasn't a bit of ground must eat his bite as he runs along (He hasn't a spot where he can eat his dinner in comfort). The white man is like the ant-bear; he

throws the ground behind him (All the Kaffir wars meant loss of land to the Kaffirs). *Umhlaba yinkosi,* the land is King.

On Efficiency and its Conditions.

Efficiency is one of our watchwords nowadays, and the Bantu have a good deal to say on this subject, and the promptitude, patience, perseverance, and self-help that are its essential conditions.

A small swarm of bees makes honey; in a big one they hinder each other ("Too many cooks spoil the broth"). The Bushman shoots with a blunt arrow, but he kills (It's not the arrow but the poison). You have tied your dog to a ragwort (You have taken ineffectual measures). They know the value of concentration of effort: *Ungepate mpuku mbili, enye iya kupunyuka,* don't carry two mice under your arm; one will slip out. Don't straighten two wands in the fire at once; one of them will burn. Don't shear two sheep at once; one of them may bite you (Do one thing at a time, and do it well). The ostrich is handling the porridge-stick (Everything is topsy-turvy; you can't do anything with incompetent helpers).

One of the conditions of efficiency is promptitude: *Ungafiiki ugane kona,* don't go and marry there (Don't delay). *Amaqotyazana angalaliyo endleleni,* they are smart little girls who do not sleep on the road. Miss Betrothed to So-and-So was married by Mr. Come-early. *Isigwaca silind' induku,* the quail waits for the stick. *Intendele elisuka muva likolwa izagila,* the partridge that gets up last gets plenty of knocks. *Libunjwa, liseva,* the clay is worked while it is fresh. ("Make hay while the sun shines.") *Ukusa akufiki kabini ukuza kuvusa umntu,* the dawn doesn't come twice to waken a man ("Take time by the forelock") Him that wakes me while it is still dark, I like by daylight (Being aroused very early in not always pleasant, but early starts make easy stages).

Indolence is the worst foe to efficiency, as Labour is its best friend: *Ngumka-Sele,* he is a frog's wife (a laggard, one always behind). *Uyinxowa yamanzi,* he is a bag of water (a useless loafer). *Kukwa-Nkomo-isengw' ilele,* it's the place of Cow-milked-lying-down (a village of desperately lazy people). *Esihleliyo sidl' ukuhlala, esipilayo sesitwetwayo,* the one that sits enjoys its ease, but the one that thrives is the one that keeps moving. His seat will stick to him, like the one Kenkeni carried on his back, is said of one who is too lazy to shift his kraal to a clean piece of ground.

Labour is the lot of all: Even among the Boers a man must work for his living, say the Basuto. Robes go from their wearers to their weavers; or: necklaces go from their wearers to their workers. The labourer is worthy of his hire, we are told. So think the Bantu, too: The milker gets the last—and richest—milk. Don't get cross with the cook; meat always shrinks in the boiling. Sometimes labour is hard: *Inkombo imbiwa ematyeni kube-Lungu,* a beast is dug out of the rocks at the white

man's (You have to work for your wages there). And it is sometimes labour lost: *Yek' ukwenz' amandla esambane*, Alas! for the mighty exertions of the ant-bear. Or: We laugh at the ant-bear, who digs a hole and doesn't lie in it, but leaves it for the ferns and porcupines.

One of the elements of Efficiency is Patience. *Soyicel' ivutiwe,* we will ask for the food when it is ready (Wait and see). The fly keeps brushing against the sore; the goat keeps rubbing against the door-screen, (both waiting their chance). *Imbewu ihlalela ihlanga layo,* the seed waits for its own seed-bed ("Everything comes to him who waits"). *Sova, singasemoyeni,* we shall hear, we are in the wind (Patience: we shall soon know all about it).

Another is Perseverance: *Umzingisi, akanashwa,* the one who sticks at it has no ill-fortune. *Isiziba siviwa ngodondolo,* the deep pool is fathomed by the long stick ("Try, try, try again") *Yoz' iyikote, yivutele,* the fire will catch the sticks by-and-by, keep blowing. Among ourselves the workman spits on his hands to take a fresh grip. *Kanamate*, say the Zulus, he has no spittle (He has no perseverance).

Another main element of efficiency and success is Self-help. Success depends on the will (where there's a will there's a way"), is the antithesis of: he moves along with the dust-cloud, (he floats with the stream). *Akuko mpukane ingakulela enye,* no fly catches for another. Two cocks don't help each other to scratch Lions don't lend each other teeth. A bird does not build its nest with another bird's down. No pheasant scratches the ground for another, or if she does it is for her young one. *Imbila yaswela umsila ngokuyalezela,* the rock-rabbit went without a tail through sending for it (instead of going himself, when tails were given out at the Creation). *Kubi ukutengelwa ngomunye, kuhle umuntu ezifikisele,* it is bad to be bought for by another, it is best to make a thing arrive for oneself ("If you want a thing well done, do it yourself"). "Save me! save me!" is slow succour ("Heaven helps them that help themselves").

Of Wisdom and Folly.

Wisdom does not dwell in a single house (No one has a monopoly of common sense). Wisdom killed the wise man ("A little learning is a dangerous thing"). *Waliposa ilizwi ladla ngokuqina,* he threw the word and it stuck firmly (His words struck home; the words of the wise are as goads, as nails firmly fixed, says Solomon). One doesn't lean over the brink of blue waters (Keep back from the edge of the precipice). Don't be in too great a hurry to answer the summons ("Look before you leap"). The second count has bettered the first ("Second thoughts are best"). The wise dam suckles her young standing up ("Ready, aye ready"). It is the crafty one whose locusts are roasted last (when everybody is surfeited). It is possible to be too clever: Cunning eats up its owner (It kills the man who makes too much use of it). *Akuko qili lazikota emhlana,* no

cleverest fellow ever licked his own back (they say of one whose attempts are far beyond his achievements). If the clever doctor does not cure you, go to one less clever. Of a particularly smart, intelligent man they say: His thoughts are at his finger-tips ("He has all his wits about him"), and of a very discreet person, "Mr. Fearful's cattle have come safe through, while Mr. Greatheart's have died" ("Discretion is the better part of valour").

Folly is most conspicuous when it takes the form of self-injury or self-destruction: You are poking a wasps' nest. You are throwing sand on a snake's back. You have introduced a crocodile into your home (all warnings against imprudence). *Ngadla inkomo yasojwini,* I ate a beast of the honeycomb, *i.e.,* a bee, means I got myself into a very hot place. *Izinyosi zidl' uju wazo,* the bees eat their own nectar ("He stews in his own juice"). *U-Zenzile kakalelwa, ukalelwa u-Jumekile,* Did-it-by-Himself is not sympathized with, the one sympathized with is Overtaken-by-Accident. *Yek' ukufa kwokuzenza,* they say—Alas! for the death of one's own making! *Udle ukudla, kwamdla,* he devoured the Kaffir-beer and it devoured him, they say of the drunkard; and to a drunk man stumbling up against one he says: *Musa ukuquba imbuzi ngakimi,* Don't drive your goats over me. No greater fool than the busybody, of whom they say: *Nguye ini umazi wezabantu (indaba), ezake zimkohlile?* Is he the man then that knows all about other people's business and mismanages his own? *Ukaulela inkawu ziya kusela,* you meet monkeys on their way to drink (you interfere where you are not wanted). He enters the thing on the slant (He interferes in a matter with which he is not acquainted). Folly is best dealt with in youth: Bend the tree while it is young, they say (As the twig is bent, the tree's inclined). *Umti wozal' isilima,* the tree will beget a crook (if it is not set right in time). *Uxam wakolwa ngamantintinti,* the leguaan was persuaded—to leave the eggs alone—by the whacks he got (a rod for the fool's back).

On Speech and Silence.

The Bantu are great talkers, and have much to say on talk and on the tongue: *Wande ngomlomo-nje,* he has grown big in the mouth only. (*Vox et præterea nihil*) The mouth has no lid to cover it, or: The tongue has no bonds (The tongue is an unruly member). *Inkomo enomlomo ayinamasi,* a cow with a tongue has no milk (Much cry and little wool, as we say). *Luluhlu luka-Qinisani,* it's the squad of Mr. Keep-at-it (who urge others to work and do nothing themselves). The tongue, however, has its uses: *Umlomo usihlyangu sokuzivikela,* the tongue is a shield to defend oneself with, or: The tongue is a man's tail-switch to drive away the flies (*i.e.,* his weapon to defend himself from annoyance). The best remedy for a dispute is to discuss it (Let him have his say; don't sit upon the safety-valve). *Uvutelwe Pakati njengevatala,* he is ripe inside like a water-melon (he is bursting to speak). But one cannot be

allowed to do all the talking: Allow me to beat you on the mouth, they say (Allow me to interrupt you).

Secrecy is all-important. *Ndifuna ukukuluma indlebe,* I want to bite you on the ear (a word in your ear). They are skinning a mouse, or: They are skinning a flea, is said of men in closes confab, or doing something on the quiet (One cannot very well skin an ox on the quiet). Silence is golden: *Umntu asint' izityand' igila,* man isn't a thing that cuts his own windpipe (A man doesn't vent his own secrets, he doesn't incriminate himself).

The Bantu are as eager for news as ever were the Athenians: *Izindaba azincitshwa, kazimabele,* one doesn't stint news, they say: it isn't corn. *Igula lendlebe aligcwale,* let the ear-calabash be filled (Tell us the whole story). *Zinqunywe amakanda, ziyekwe,* their heads are cut off and they are left, may be the reply (I have told you the main facts, no need to go into details).

On Truth and Falsehood.

A cow is not milked on the ground where there is a pail ("Good wine needs no bush; the truth needs no armour"). But the truth is often not believed: *Imbuzi ingazal' inkoma nomlungu atung' isicoco,* the goat will bring forth an ox and the white man wear a head-ring (before I believe that). *Tina sibamb' elentulo,* we hold by the lizard's story, (*i.e.,* by what we were told first. At the creation of man, *u-Nkulunkulu* despatched the chameleon to tell men that they were to live for ever, and later on he sent the lizard to tell them that they were to die. The chameleon wasted his time eating the little red *kwebazana* berries on the way, so the lizard arrived first and told his story, and when the chameleon arrived nobody would believe him, and so men are mortal). The truth is often denied, and denied with a strong asseveration and gesticulation: *Ukanyele walala ngomhlana,* he denied it till he lay on his back; *ukanyele ukuma ngobontsi,* he denied it standing on tiptoe; *upike wabuquza ngesilevu pantsi,* he contradicted the statement till his beard swept the ground. The truth is often exaggerated: *Babik' ibiba, babik' ibuzi* they report a field-mouse, then they report a rat (so the story grows in the telling). Didn't you say that it (the pig) was as big as a bull? *Wenz' esenyoka,* he makes a snake story of it. The tongue gets to the place where they count how many skins went to the making of the kaross (or, as we say, where the angler told how many fish he had caught). Your words overlap (You contradict yourself).

On Fidelity and Treachery.

Inja ayilum' umniniyo, a dog does not bite his master. *Angiyi kubuyela emuva, anginjengomgqigqo,* I am not like the reversing waltz, there will be no going back with me. *Yandifaka ekwapini,* he put me in his armpit (He took me under his protection). In the brave man's house there is weeping, in the coward's there is none (They are afraid even to weep for their dead).

Lunyawo lwemfene, it is the baboon's foot (He shows the cloven hoof). *Ukaka kampetu*, he is a shield reversed (a turncoat and traitor). *Ungumsonto onyikinyiki*, he is a wet thread, which rucks and will not go into the holes pierced for it (he is thoroughly unreliable). *Intsiza-mbulala*, one who helps and kills, or: *Uyikot' eyixatula*, he licks the wound while tearing it open (He is a false friend, a wolk in sheep's clothing. *Umvundla ozikundla zibili*, a hare with two holes to its lair; *intlolela yombini*, a spy for both sides; a needle pointed at both ends (One who runs with the hare and hunts with the hounds).

On Sorrow and Consolation.

Sihlezi emanzini, we are sitting in the water (in discomfort and anxiety). *Uhleziwe ilahle emhlana*, he has a live coal sitting on his back (He is in great concern). *Ukufa kwentliziyo ngumzwangedwa*, the dying of the heart is a thing unshared (The heart knoweth its own bitterness). The water has dried up first in the pot and then in the ladle, is a saying that indicates utter failure. That you should come to see an old vulture with his neck plucked like me, expresses utter misery. I am a stump, a pollarded tree, is said of one bereft of wife and children.

But there is consolation: Leave the spilt porridge and keep what you have (There is no use in crying over spilt milk). The good guinea-fowl cries while it shuffles along (Don't sit down and give way to grief, keep moving and put things right). Sorrow will roll away like the morning mists before thhe sun. *Umhlaba kawunoni*, the earth does not get fat, however many are buried in it ("O grave! where is thy victory?"). We have come to console you; we have come to bring you out of the forest; *akuhlanga lungehlanga*, there has not happened (now) what has not happened (before). (Death is the common lot.) And there is the courage of despair. *Ake silahle amatunga*, let us throw away our milkpails—though milk is the staff of life to the Bantu (Let us burn our boats; let us make a last desperate effort).

On Life and Death.

Life is full of vicissitudes, it has many ups and downs: *Ukuhamba kuzal' induna, kuzal' intsikazi*, the course of nature brings forth now a fine male, now a poor female (Do not expect a lot of unmixed blessedness). *Ukwenza kuya emuva, kuye pambili*, action goes now back, now forward (Time and chance happen to all). *Indlala itata osemnyango impose emsano, osemsano impose emnyango*, misfortune takes the one at the door and throws him on the dais, and flings the one on the dais to the door. The game *will* appear on the side of the inexperienced hunter. I know him, the lucky fellow, he's as lucky as a wolf (Throw him into the Nile, and he'll come up with a fish in his mouth).

And life and its joys are transitory: *Akuko ukanga indubul' ingeti*, there is no ragwort that blooms and does not wither.

Uhlangene nembila zicitakala, he came upon the conies as they were dispersing (He did not long enjoy his good fortune). A man falls with his shadow (*Sic transit gloria mundi*). Whence we come is far away, whither we go is near (Our days are drawing in). The bull does not bellow at the second ascent (Our dancing days are done).

Itshoba lanquma, the tail- brush stiffened: *itshoba lalala umbete,* the tail-brush lay on the dew; *kwahlanza uselwa,* the calabash threw up its contents; *ucilo ulahle intete,* the tinkie has let go the grasshopper, are all expressions for the article of death. *Ngongubo ziy' eweni,* his garments are off to the precipice; *sekubekwe intlamvunje,* a branch has already been laid over him, are said of one as good as dead. There is a plan, they say, for dealing with everything but death. Death has many petticoats (There are many ways of dying). *Incibi yamanzi ifa ngamanzi, eyezikali ifa zikali,* the waterman dies by water, and the spearman by the spear. *Elokuf' alityeli,* the hour of death gives no warning. Death is in the fold of our mantle. Death is always a new thing. *Akuko mmango ungenaliba,* there is no hillside without its grave. The leopard dies with his spots (the chief with his policy and plans and renown). *Lento umntu iyemka nok' ibongwayo,* this thing man departs, however celebrated he is. It is the known tree that is felled (It is the prominent man that is marked for denunciation and death). A man is admired after his death (*De mortuis nil nisi bonum*). *Ngiza kumlandula Mzila,* I have come to excuse Mzila (*Mortuus est*). *Awu! Mazwana usele!* Alas! Mazwana has remained behind (dead on the field of honour).

(*Finally received, July 27, 1917.*)

TRANSACTIONS OF SOCIETIES

Chemical, Metallurgical and Mining Society of South Africa.—Saturday, September 15th: G. Hildick-Smith, B.Sc., President, in the chair. —Presidential address: G. **Hildick-Smith.** The address, at the outset, referred to the want of co-ordination and systematic research work in all branches of industry in the British Empire, and went on to apply this, as a general axiom, in particular to the underground work on the mines. Reference was made, in the first place, to the essentials for carrying on a research department, and then to the branches of work which such a department could profitably undertake.—"*A logarithmic calculator*": D. R. **Robinson.** A description of an instrument, essentially a circular slide rule, introduced in several survey offices on the Rand over a year ago, for the purpose of reducing planimeter readings of mine plans to tonnages and areas on the dip.

NEW BOOKS.

Young, F. B.—"*Marching on Tanga (with General Smuts in East Africa).*" 8 × 5 in., pp. xii, 265; map, illus. London: W. Collins, Sons & Co., Ltd. 1917. 6s.

Du Pleesis, Rev. Prof. J.—"*Thrice through the Dark Continent.*" 9 × 6 in., pp. viii, 350. Maps and illus. London: Longmans & Co. 1917. 14s. net.

Loram, Dr. C. T.—"*The Education of the South African Native.*" pp. xx, 340. London: Longmans & Co. 1917

ENTOMOLOGICAL EDUCATION IN THE UNITED STATES.

By Eric S. Cogan, M.A., Ph.D.

America now justly and rightly enjoys the title of being the home of applied entomology. While it seems but a short space of time since the first pioneer efforts at insect control were commenced, yet our knowledge of the subject has advanced steadily, and in the main along general and specialized lines, till it has reached its present proportions. Founded on the excellent work of Say, Harris, Fitch, Le Baron, Walsh, Riley, and Lintner, the study of entomology has progressed, and to this progress the educational institutions have contributed no small portion. The advance of our knowledge of agriculture, with its specialized methods and its many phases which require scientific research and ardent investigation, has created a demand for trained entomologists, and to meet the requirement, the universities and colleges have instituted special courses of instruction. The amazingly rapid development of the agricultural resources of the United States has created the necessity for trained men to cope with the many diverse insect problems of the land. Apart from agriculture, our knowledge of the rôle which insects play in the transmission of disease has almost made it imperative that some attention be paid to the training of men to deal with such problems, which affect the health of man so closely. So that it is no wonder that one finds to-day in the American universities experienced teachers and investigators, with well-equipped laboratories, giving of their knowledge to the coming generation.

It is not within the scope of this paper to deal at length with the educational methods or the system of education in the American universities, but the aim is to present some idea of the courses given and where they are best obtained, together with some of the opportunities for learning, which are offered. But before doing so, it will perhaps be better to explain that in the main universities and colleges in the United States may be roughly divided into two sections, viz., the State universities and the privately endowed schools. Each State maintains at least one university, and sometimes more, as is the case in Ohio, where there are four, and it is at these State universities where one finds the great attention paid to the study of agriculture and agricultural sciences. Generally working in co-operation with the State university is the State experiment station, and frequently the two are in one. The privately endowed universities on the whole do not devote as much attention to agriculture, although a great deal of scientific research along agricultural lines is accomplished within their walls.

For purposes of discussion we may divide the universities of the States, with respect to entomological education, into three groups. Under the first group we may consider: Massachusetts

Agricultural College, Amherst, Mass.; Cornell University, Ithaca, New York; Ohio State University, Columbus, Ohio; University of California, Berkeley, California; and Illinois State University, Urbana, Illinois. The second group would include the universities of Wisconsin, Kansas, Indiana, Purdue, Michigan, Iowa, Colorado, Minnesota, State University of Pennsylvania, Harvard University, and several others, while the third group would include many of the agricultural colleges of the Southern States, and those schools where entomology is taught in the general agricultural curriculum.

In group I we find some of the foremost universities in the United States distributed from the east to the west coast. And it is from these schools that the United States Bureau of Entomology and the many State experiment stations draw their investigators and workers. Some years ago Dr. Howard, Chief of the United States Bureau, showed in a paper that these five schools provided by far the greater number of entomologists at work in the country. Besides, these schools have supplied, and are supplying, a great number of teachers in the field of entomology.

Being a truly agricultural science, entomology naturally will be found in the curriculum of the agricultural college of the university. In the Ohio State University at least one course in economic entomology is required before graduation from the College of Agriculture, and the same is doubtless true of the other members of the first group. Undergraduate work extends over a period of four years, and during that time the student has ample opportunity to specialize in whatever field he may wish. Should he choose entomology as his prospective field, then his first year's work would be that prescribed for the College of Agriculture, and his courses of study would include elementary zoology (as the fundamental preliminary training), botany, chemistry, etc., along with his language, etc. In his second or sophomore year he would be able to take courses in entomology, apiculture, evolution, horticulture, and perhaps an elementary course in plant pathology. The third or junior year is generally regarded as the time for specialization to begin, and it is here that the student will have "found himself," and will be in a position to decide further what branch he wishes to pursue. Courses in advanced entomology, economic entomology, taxonomy, invertebrate morphology, bacteriology, and plant pathology would take his attention. Thus, by the end of the third year, he will have had a broad fundamental training in his science, as well as those closely related, and he ought to be in a position at the beginning of his senior year to take up a minor research problem under the immediate guidance of an instructor or professor. His prescribed courses for the last year would include invertebrate embryology, medical entomology, genetics, animal reactions, entomological literature, together with a seminar each week. In case of a seminar, each student is assigned a subject generally on some recent advance in ento-

mology, and it is his duty to prepare and present a paper embodying his readings before the whole class and the faculty members. An excellent opportunity is thus afforded in preparation and presentation, because criticisms and questions are always part of the programme.

While in the main the above outline would indicate the general plan for the student, it must by no means be construed as the only plan, for each university has its own particular method, and in some the methods of giving and allotting courses would differ. Where facilities are offered, additional courses may be obtained in diseases of insects, aquatic entomology, etc.

During the long summer recess many students of entomology spend their vacations in the employ of the United States Bureau of Entomology or the State experiment stations. Here ample opportunity for field work and experience are obtained, and it is indeed surprising to see the difference which a summer's work will have in a student's outlook on his subject. As it is to the United States Bureau of Entomology and the State experiment stations that the majority of student entomologists look for future employment, it is only natural that a few summers spent in the work are of inestimable value.

Again, the summer vacation may be spent in supplementary study either at the Summer School of the University or at one of the field laboratories, on the great lakes, or at the coast. The writer recalls with great pleasure a summer spent at the Lake Laboratory on the shore of Lake Erie.

In the majority of the universities of the first group the courses outlined are generally similar. Especial attention is everywhere given to training in laboratory work and technique. One lecture a week would be supplemented with at least two or three hours in the laboratory. During his last year a student, if he shows the ability, may be appointed a student-assistant in the laboratory in which he would be required to aid in laboratory demonstrations under the direction of the instructor. Thus, when he receives his degree, the student will have had a broad, liberal training, which should fit him for work almost immediately.

Examinations are held at the end of each semester (roughly, four and a half months), of which there are two a year, and on the sum of the four years' standing, the student receives his degree. As the degree given is that of Bachelor of Science in Agriculture, the diploma will state the subject specialised in. On the other hand, a student reading for the B.A. may similarly specialize.

Advanced or graduate work in all the universities is administered under the Graduate School, and the work leads to the degrees of M.A., M.S., and Ph.D. It is, however, absolutely necessary that a student have ample preliminary training in his subject before entering on graduate study, and failing this he may be required to supplement his regular work with additional courses. For the degree of M.A. one year wholly devoted to

graduate study is required; a satisfactory thesis must be presented in the major subject, and one or two minor subjects must be taken. Final written and oral examinations, covering both the major and minor subjects, are given before the degree is awarded. A student majoring in entomology is most generally advised to select as his minors one or two of the following:—Bacteriology, plant pathology, horticulture. If his undergraduate work has led to the degree of B.A., then the master's degree generally conferred would be the M.A.; if it has led to a B.S.A., then the M.S. would be the advanced degree. However, this order of arrangement may be changed if circumstances necessitate. The courses given during graduate work are all advanced, and aim to give the student a broad outlook on his science.

For the degree of Ph.D. not less than three years of graduate work or two years wholly devoted to graduate study after receiving the master's degree are required. A major subject and one or two minors may be taken, the latter to be in subjects related to the major. Research and extensive readings, reviews of current literature, familiarity with contemporary workers, their methods and results, play the most important part in this work, and the student must familiarise himself with the history of his subject. He must show a reading knowledge of both French and German, to enable him to use these languages for reference or other purposes. His dissertation must embody a contribution to our knowledge of the subject, and must be published at least before one year has elapsed from the time of its acceptance. Written and oral examinations covering every phase of the major and minor subjects are given.

While it is not absolutely necessary that a student spend the whole of his graduate study in the university, some independent workers continue in the Bureau of Entomology or in the State experiment stations, and their work is directed by the professor in charge of the candidate. Thus it is possible for men to gain advanced degrees without materially affecting their positions.

For graduate work in entomology, as well as in many other subjects, scholarships are offered, and enable many students to pursue advanced work. These scholarships are of the nature of teaching scholarships, when the student spends half his time in study and the other half teaching elementary classes, for which he receives a certain remuneration; or a straight scholarship, which gives to the student a stipend without requiring him to teach, but devote his whole time to study. Such scholarships do a great deal towards encouraging worthy students to go forward in their studies.

Thus far I have outlined the courses of instruction with some comments on other phases of entomological education, but I cannot proceed any farther without mentioning something about the relationship between student and teacher. In advanced work especially, the conferences, consultations, and associations with their professors play an exceedingly important

part in a student's work, and it is here, I think, that graduate work in any university finds its greatest asset. I well remember an eminent Professor of Anatomy telling me of the great stimulus it was to him to come into contact with the keen, ambitious student, and to watch the development of the man in his work. The same told me of a conference with a student regarding selection of a problem for the Doctor's Dissertation. The student, young and inexperienced, had decided on a certain problem which he considered would meet his requirements, but on coming to discuss it with his teacher, the student was amazed to find his problem dismembered and reduced to a fraction of its original size. Here the timely advice and direction of the teacher saved the student much disappointment, which would inevitably have followed his working on too great a task.

Students at American universities have a great many opportunities on the outside for gaining information. Numerous scientific societies and clubs give them scope for exchange of ideas. Thus at the five schools mentioned in the first group, as well as in many of the others, there are respectively a Biological Club and Natural History Society, which encourage students to present papers, besides being instrumental in bringing famous speakers, lecturers and experts to deliver addresses. The Society of Sigma XI, to which one is elected on the basis of ability to undertake original scientific investigation, holds out on honour which the student regards with much envy.

I have dwelt mainly on the five universities of the first group with regard solely to their entomology. The schools of the second group do prepare students most thoroughly in entomological work, but they have not yet given the especial attention to it that the members of the first group have. A great many students will graduate from these colleges and repair to the schools of the first group for their advanced studies. Of the third group I shall not say much beyond that it includes those schools and colleges where entomology is taught in the general curriculum in the Agricultural College or the College of Arts and Science. Students at colleges in both this and second group do specialize, but as a general rule they are isolated examples, and proceed ultimately to the larger universities for their final training.

In conclusion, I would say that the advantages and benefits to be derived by the student of entomology in the American universities are boundless. There is opportunity everywhere, and the student can well spend the time to the greatest advantage.

(*Read, July* 6, 1917.)

THE PLACE OF PROTEIN IN NUTRITION.

By John Carl Ross, B.A., M.S., Ph.D.

Only fifty or sixty years back the farmer had no means whatever to guide him in choosing rations for his stock. He fed his animals as he had seen others do before him, but had no notion of what it was that nourished the animals, why one feed was better than another, and so forth. The middle of last century may be said to mark the beginning of animal nutrition as a science, and since then its development has been remarkably rapid, especially during the last few years.

But as our knowledge of animal nutrition has advanced, apparently innumerable new problems have presented themselves. Thus, we have been accustomed to judging the value of a feed largely on its "nutritive ratio," which expresses the relation between digestible carbohydrates + digestible fat, expressed in terms of carbohydrate and digestible protein. Different digestible carbohydrates and fats probably do not differ much in nutritive value. But it is not true, as was thought until quite recently, that one protein is as valuable as another for the maintenance and growth of farm animals. It is now well known that proteins differ, and may differ markedly, as regards their nutritive value. For example, if we feed to an animal the protein casein, which is obtained from milk, supplemented with the other necessary non-nitrogenous nutrients, we obtain good growth and fattening. But if we substitute gliadin, one of the proteins of wheat, for the casein, no growth is produced, though the ration suffices for maintenance. If we use zein, one of the proteins of maize, neither growth nor maintenance will be obtained, and the animal will decline in weight more or less rapidly.

Researches during comparatively recent years have shown that proteins are built up essentially of large numbers of simpler compounds, called amino-acids. At least 17 amino-acids are known to have a rather wide distribution among the different proteins, and a few others have been identified in isolated instances. It has been definitely established that the differences in nutritive value of proteins are due to differences in their amino-acid content. It is obvious, then, that the nutritive value of the proteins of feeding-stuffs for farm animals can be determined only by thorough and extensive studies of the amino-acids which constitute the proteins.

This opens a new and almost unlimited field of study. The investigator in animal nutrition to-day is being confronted with the problem of determining the precise nutritive value of each of the many amino-acids occurring naturally in feeding-stuffs. Already significant results have been obtained. For example, we are now reasonably sure that the amino-acid "tryptophane" is essential for maintenance, and the amino-acid "lysine" essen-

tial for growth. Casein contains both in sufficient quantity for maintenance and growth; gliadin of wheat contains tryptophane, but very little lysine, and thus will not produce growth, though it suffices for maintenance; zein of maize contains neither tryptophane nor lysine, and therefore suffices for neither growth nor maintenance. On the other hand, when zein is supplemented with tryptophane, maintenance is secured; upon the further addition of lysine, fairly rapid growth is secured. Even normal growth has been obtained with zein when further supplemented with "arginine," another amino-acid in which it is markedly deficient.

Feeding experiments have led us to the conclusion that the so-called "protein requirement" of animals is simply a requirement for definite amino-acids, and varies for different proteins in strict accordance with their amino-acid make-up. The protein casein is comparatively deficient in the amino-acid "cystine," and it is found experimentally that the minimum requirement of casein supplemented with a little cystine is lower than that of pure casein. Incidentally, this indicates the importance of cystine as a protein constituent.

In order to obtain a better knowledge of the nutritive value of the proteins of feeding-stuffs, three important lines of investigation suggest themselves. These are: first, a quantitative supply of the amino-acids of feeding-stuffs; second, feeding experiments on the substitution of protein in rations by definite mixtures of the amino-acids occurring in feeding-stuffs; and third, feeding experiments to determine the nutritive value and relative efficiency of the proteins of feeding-stuffs.

Determinations of the amino-acid content of isolated proteins, such as have frequently been made in the past, are not of great practical importance to problems of live-stock feeding—the feeding-stuffs themselves must be studied. It is impossible as yet to isolate quantitatively in a pure state the proteins of any vegetable tissue; furthermore, the nutritive value of a feed so far as the nitrogen is concerned rests upon its total amino-acid content derived from both proteins and pre-existing free amino-acids, amides, etc., and not solely upon the amino-acids combined in protein form. Moreover, practical animal husbandry men have always to deal with the natural mixtures of proteins, or, better, amino-acids as they occur in our ordinary feeding-stuffs. It seems quite evident, then, that it will be necessary to determine the total amino-acids of feeding-stuffs directly. It is more than probable from recent work carried out in America that the method of Van Slyke for the analysis of proteins by determination of the chemical groups characteristic of the amino-acids can be applied with a fair degree of success to the direct analysis of the nitrogen of feeding-stuffs. The method of Van Slyke is incomplete, since it does not give an insight into the amount of each amino-acid present in the protein or the feeding-stuff; but it is undoubtedly the best method available at present, and there is little doubt that the results obtained from the use

of this method will be of considerable value in the interpretation of the results of feeding experiments.

Feeding definite mixtures of amino-acids in place of protein is a line of investigation which will perhaps throw more light upon the nutritive value of the proteins of feeding-stuffs than any other. It has been shown that the animal organism can be maintained in equilibrium, and even normal growth secured, when the nitrogenous requirements are covered by preparations obtained by completely hydrolysing protein material, when presumably only amino-acids (and small amounts of amides) are present. By completely removing certain amino-acids from the mixture of the products of protein hydrolysis and determining the nutritive value of the residual mixture of amino-acids it can be clearly demonstrated whether or not the amino-acids removed are indispensable to maintenance or growth, or both.

Other workers have used as a sole source of nitrogen in rations isolated and carefully purified proteins obtained from a wide variety of sources, and have shown that different proteins have different values in nutrition. Those differences have been traced very successfully to differences in the amino-acid content.

By these methods the significance of several of the amino-acids have been made evident. It is an unfortunate fact that amino-acids are very expensive and otherwise difficult to obtain in quantity, so that it is out of the question to attempt to feed amino-acid mixtures to farm animals.

Most of our present knowledge of the rôle of amino-acids in nutrition has been obtained from the results of feeding experiments with small animals, usually mice or rats, in which isolated proteins or definite amino-acid mixtures were used as the sole source of nitrogen. Such results are of fundamental importance in revealing the character of the chemical processes involved in nutrition, but are not necessarily fully applicable to farm animals.

The third line of investigation suggested, namely, feeding experiments to determine the nutritive value and relative efficiency of the proteins of feeding-stuffs, will probably appeal to the practical animal husbandry man more than the previous two. Practical animal husbandry men must always deal with the natural mixtures of proteins as they occur in ordinary feeding-stuffs. Moreover, we can use farm animals for this work, as there need be no special expense involved in the preparation of the rations beyond the ordinary market cost of the feeds, and no question of the applicability of the results obtained to practical stock-feeding. Of course, this line of work is closely related to the previous two suggestions, and would yield a greater measure of success, the greater the progress attained in the other two directions, since the object would be to interpret the results of the feeding experiments in terms of the amino-acid content of the rations fed, if it be possible to do so.

It is impossible, as yet, to outline in detail final plans for feeding experiments with the natural mixtures of amino-acids as they occur in ordinary feeding-stuffs in order to demonstrate the relative efficiency of the amino-acids for maintenance and growth until further data have been secured from the researches of the first two divisions. In such experiments the necessity for exactly controlled conditions is obvious, and cannot be over emphasized. Recent experiments indicate clearly that in restricted but natural rations certain accessory compounds which the animal organism cannot synthesise may be absent, or in some cases it is possible that toxic materials may be present to exert a slow but detrimental effect. Further, it has been shown in the case of swine that unknown factors operative in the normal environment of this species, such as soil-rooting and natural water, are of considerable importance, and may affect its nutrition. The importance of the mineral side of a ration has also been well established. Further, the researches of the last few years have clearly demonstrated that nutrition experiments of short duration, even when accompanied by elaborate chemical and physiological analysis and examinations, give but little, if any, insight into the value of a feed for long-continued, normal and healthy growth.

In view of these considerations it would seem that the first thing to be accomplished is to select some one standard ration, and demonstrate beyond a doubt that this ration under exactly controlled conditions will produce normal growth for a long time, say, six to ten months.

It is not my intention to suggest detailed plans for such an experiment, but if the above conditions can be obtained, we shall have an excellent standard upon which to base future work. Further, direct experimental evidence will be obtained that this ration contains all the necessary food nutrients, and all the essential compounds like vitamines, lipoids, etc., required for the maintenance, the growth, and the fattening of the particular animals used; also, that this ration does not contain toxic materials that exert a detrimental influence on growth.

Such studies mark the beginning of a new era in the chemistry and physiology of nutrition. Our rapidly increasing evidence on the nutritive functions of the amino-acids will no doubt be helpful in the interpretation of past and future feeding experiments. Is it not possible that in the near future we shall calculate balanced rations from their amino-acid content that will be most efficient for maintenance, growth, and fattening of farm animals? Undoubtedly the practical and economic importance of modern nutrition investigations will be appreciated by the general public only when the findings make possible a better economic and nutritive valuation of feeding-stuffs. An eminent authority has said: "It is perhaps not too utopian to expect that the day may arrive when amino-acid concentrates may serve to render perfect the mixture of proteins in a fodder like maize."

(*Read, July 5, 1917.*)

THE SCOPE OF RADIOLOGY.

By Jan Stephanus van der Lingen, B.A.

(*Abridged.*)

Radiology is the study of the physical, chemical and physiological properties of all kinds of radiations. In order that we may form some idea of the origin of radiations, it will be necessary to consider very briefly the constitution of matter.

Matter, on being subdivided, yields the fundamental unit—the molecules of the particular chemical compound. These molecules are built up of similar atoms or an assemblage of certain groups of different kinds of atoms. The properties of the molecules depend upon the arrangement and properties of the atoms.

Atoms, again, are built up of constellations of electrified units, which we name corpuscles. These corpuscles gyrate round certain centres of force within the atom, and thus we may imagine the atom to represent a miniature universe with its planets and fixed stars. From this we see that the properties of the atom depend upon the corpuscular constellations. Should these constellations be changed, the chemical properties will also be changed, hence the various elements represent particular constellations of corpuscles.

When energy is communicated to the corpuscles, their speeds will undergo a change, and this change in speed must be balanced by the forces which keep the corpuscles in their orbits. If the forces do not balance the new speed, the corpuscles will fly off from the former orbits and become the comets of this micro-cosmos.

In the radio-active substances we have an instance of these comets.

The difference in our analogy is that these comets are large, and thus disturb the equilibrium of the planetary system of the atom. The débris of the original atom probably tends to re-establish equilibrium. The re-established system will be different from the former, hence a new atom is born. This atom is probably not in harmony with its neighbours, and consequently must part company. As an instance of this we have helium, a product of radio-active matter. Thus alchemy does exist, but Nature alone, thus far, in her laboratories performs these transmutations.

These emitted corpuscles, which we have mentioned before, form the corpuscular radiations. The gyrating corpuscles in the atom may, under certain conditions, set up periodic pulses in the surrounding medium, and thus cause light to be emitted, which is propagated in the form of wave motion.

The properties of these radiations will depend upon the frequency of the pulsation caused by the corpuscle. The light emitted is thus characterized by its wave-lengths—that is, the distance which each component part of this wave motion passes over between two consecutive pulses.

A ray of visible light falling obliquely on the surface of a prism of glass or quartz is deviated from its original path, and this deviation is different for different kinds of light; hence, when composite light falls on the prism, the constituent parts will be deviated in definite directions, and form a series of colours on the receiving screen. This series of colours or of bright lines is called the spectrum of the light.

If a bar of metal is gradually heated and its spectrum observed, the following phenomenon is seen: Initially no visible light appears, but heat is radiated—that is, invisible light is given off. Subsequently the metal begins to glow, and a dark red light is seen in the spectrum. As the heating is continued, the following additional colours appear consecutively: Orange, yellow, green, blue, and finally violet, where the visible spectrum ends.

The visible region of the spectrum forms only a small fraction of the complete spectrum of radiations. This region extends from the wave-length 0.0008 millimetre—the red end—to wave-length 0.0003 millimetre—the violet end. Beyond the red end, we have the long wave-length heat rays (0.06 millimetre), and the Hertzian or electro-magnetic rays (10,000 metres). Beyond the violet end, we have the short actinic (Schumann) rays (0.0001 millimetre), and the *X*-rays (0.000000001 millimetre).

From what has been said about the radiations given off by an incandescent solid, we notice that the short wave-lengths appear at a higher temperature than the long wave-lengths; hence, by observing the spectra of stars, we may form some idea of the temperature of the stars, and by comparing the spectra we may construct a celestial thermometer.

The spectrum of an incandescent solid is one continuous band of colour, whereas an incandescent gas generally gives a spectrum of definite bright lines only, and these lines give us a clue to the nature of the gas.

These bright lines are replaced by dark lines in the spectrum if the light from an incandescent solid passes through a layer of the same gas at a lower temperature; thus the dark lines in the spectra of stars indicate the presence of definite gases between the observer and the star. Hence the temperature and constitution of a star are revealed in its spectrum. When the source of light moves relatively to the observer, the waves of light are compressed or expanded, hence there is an apparent change in the wave-lengths; consequently the "shift of the lines" indicates the direction of motion of the source; thus the temperature, constitution, and motion of celestial bodies are shown in the spectra.

Just as a gas has a definite absorption spectrum under definite conditions, so, too, liquids selectively absorb definite radiations when light is transmitted through them. The energy of the radiations which are absorbed may be used to cause new radiations. An instance of this is fluorescence.

This selective absorption is met with in the pigments of

plants and animals. The colour of a plant is generally due to the presence of certain pigments. These pigments absorb certain radiations of the incident light and reflect or scatter back the remainder. The scattered light determines the surface colour of the body. The energy of the absorbed radiations is generally utilized by Nature to promote growth. The radiations of the red end of the spectrum are those usually employed to promote metabolism, whereas the action of the radiations of the violet end is katabolic. The green colouring matter in plants—chlorophyll—absorbs the blue rays of light, and converts them into beneficial red rays. The action of pigments in plants is further demonstrated in the case of seaweeds. At the surface they are green, and the colour gradually changes with the depths at which they are found; thus they finally develop to red. Sunlight, as it passes through the water, is gradually absorbed, the red rays being absorbed more readily than the blue rays; hence the latter penetrate to the greater depths. At this depth we find only the red seaweeds. The pigment in these plants converts the destructive blue rays into beneficial orange and red rays.

Both in plants and animals the pigments protect the underlying tissues from destructive rays; thus sunburn, which is caused by the short, that is blue, rays is generally followed by pigmentation. The continual exposure to the action of the sun possibly caused the formation of melanins, the colouring matter in the skin of the coloured races. This pigmentation forms a protection; thus the negro or kaffir has a better chance of existence in his birthday suit than a white man, when both are exposed to excessive solar radiations.

It has been found that white cows, fed on buck-hay and exposed to the sun's rays, get a rash, whereas coloured cows do not suffer from the rash on account of the protective pigments. Artificial colouring of a white cow acts in the same manner. Another detrimental effect of blue rays is that they cause pitting in the skin of a small-pox patient, hence the patient is placed where only red rays will reach him; but it has been found that the blue rays as well as the red rays are beneficial in the cases of certain skin diseases. It may be that the beneficial effect caused by the blue rays is the result of pigmentation combined with the formation of antitoxins, hence the good results obtained by "sun-bath cures." When indulging in a sun-bath the head should be protected, because the yellow-green rays cause sunstroke.

From what has been said above, it follows that it is advisable to wear yellow-green or white headgear, as these colours absorb or scatter, respectively, the injurious rays.

Speaking of the effect of actinic rays in the case of skin diseases brings us to the bactericidal action of these rays. We have already pointed out that, in the case of plants, blue rays destroy life, whereas the red encourage growth. In general the effect of these rays on bacteria is analogous with that on plants. We all know that stagnant water is apt to be the stronghold of

disease-bearing bacteria, yet few of us care to enquire how Nature protects us in this case. The solar heat dries the pools, unfortunately heat also encourages the growth of bacteria. At the same time, the blue rays come to our aid; they kill off the bacteria in a short time, and also penetrate to a greater depth than the red (heat) rays.

In experiments with actinic rays of mercury lamps it was found that the dangerous bacteria of cholera, typhoid, and dysentery were killed in less than 20 seconds, whereas the harmless yeast bacteria lived after 300 seconds.

From what has been said, it will readily be seen that exposed pools are less dangerous than those hidden in sheltered places. The latter receive heat from the earth by conduction, and are at the same time screened from the actinic rays.

This bactericidal action of the actinic rays is applied in modern waterworks to sterilize the water.

Actinic rays produce hydrogen peroxide—a good oxidizer—when they pass through water, but it is not the effect of this action which is principally responsible for this sterilization.

Thus far we have considered radiations whose wave-lengths lie between the values 0.0008 millimetre and 0.0001 millimetre. Let us now consider *X*-rays, which lie far beyond this region with 0.000000001 milimetre. *X*-rays are characterized by the following general properties:—

(*a*) Penetrating effect;
(*b*) Photographic and chemical effect;
(*c*) Fluorescent effect;
(*d*) Ionizing effect;
(*e*) Physiological effect; and
(*f*) Optical properties.

These properties will be better understood when we consider briefly the origin of *X*-rays.

Under certain conditions *X*-rays are produced as the result of the bombardment of solids by corpuscles moving at a very high speed. The energy which these corpuscles impart to the solid sets the electrons vibrating in a definite manner, consequently the character of the radiation will be determined by the constitution of the target and the energy of the bombarding corpuscle, which may cause some or all of the corpuscles of the solid to give off their characteristic radiations.

(*a*) Penetrating Effect.

Substances which are opaque to ordinary light are more or less transparent to these rays. Targets of high atomic weight generally produce rays which are more penetrating, *ceteris paribus*, than targets of lower atomic weight, and dense substances are generally less transparent than substances of low density. This readily explains that it is easy to obtain a photograph of the bones and the opaque parts of a body.

(*b*) Photographic and Chemical Effect.

The chemical action of these rays upon a photographic plate depends principally upon two things—the penetrability of the rays and the current sent through the tube. The more penetrating rays are less effective than the weaker, softer or less penetrating rays. When the hardness of the rays remains the same, the photographic effect is augmented by increasing the current through the tube, so much so that it is possible to obtain a "snapshot" of the moving parts of the body, such as the heart, etc. In this connection it is worthy of note that the emulsions, of which the film is made, play an important part. The more absorbent the emulsion is, the more satisfactory would it be for obtaining skiagrams of bodies.

The hardness of these rays is classified according to arbitrary scales of penetrability, usually the penetrability relative to thicknesses of aluminium. This enables the radiographer to standardize the radiations required for the diagnosis for different parts of the body.

Besides the chemical action on a photographic plate—these rays also produce precipitating and other chemical effects, *e.g.*, iodine is precipitated from its solution in chloroform, and ammonium oxalate-mercury bichloride mixture precipitates calomel. Barium, magnesium, and potassium platino-cyanides change colour due to de-hydration.

These chemical effects enable one to measure the quantity of the radiation, thus pastilles and emulsions on paper or plates are used to determine the dosage given to a patient.

(*c*) Fluorescent Effect.

Certain compounds of uranium and alkali salts, and also alkali earth metals, emit light when *X*-rays fall on them. The intensity of the fluorescent light varies inversely as the square of the distance of the substance from the target of the tube. This effect is applied in screens for localising foreign bodies, thus obviating the necessity of photographing the affected parts. This method, however, leaves no record for future reference.

(*d*) Ionising Effect.

When a gas is exposed to the action of these rays it breaks up into electrically charged particles or ions; that is to say, the gas becomes ionised, and in that condition conducts electricity. The amount of ionisation produced in a given time depends upon the nature of the gas, its pressure, the potential difference across the tube, the inverse square of the distance from the target of the tube, and the penetrability of the rays, but it seems to be independent of the temperature of the gas. This principle is utilised especially by physicists for making quantitive measurements.

Before going on to the physiological effect, we shall say a few words about secondary rays. When *X*-rays fall on sub-

stances, they cause those substances to emit certain radiations. Such rays are called "secondary." These rays have properties which depend upon the nature of the substance from which they originate, and these substances or radiators are classified into groups according to their atomic weights. If the radiator be a chemical compound, the secondary radiations depend upon the chemical constitution of the radiator—*e.g.*, the secondary radiations from salts consist of two parts—(1) homogeneous radiations, having the same penetrability as those from the metal; (2) scattered primary radiations, considerably more penetrating than the homogeneous radiations. The latter are due to the acid radical.

If the metal occur in the acid radical, it merely acts in conjunction with the rest of the radical.

The characteristic radiation of a substance is only emitted when the primary radiation has sufficient energy to bring it into play.

(*e*) Physiological Effect.

The action of *X*-rays causes nuclear changes in cells. These changes are generally of a degenerative character. Experiments on ova show that under certain conditions cell division is retarded, and frequently the fœtus is a monster.

When pregnant female rats are irradiated the young are less virile than the controls, and they rarely live for one month. In appearance, too, they are smaller than the normal young. In three cases under our observation the females were sterile for a period of seven months. During this period they behaved like normal rats. One female (white rat), which was treated frequently from the first signs of pregnancy, gave birth to eleven abnormally small black rats. They all died within five weeks after birth. A similar pigmentation has been recorded in the case of butterflies.

Thus far rodent ulcers, sarcomata, carcinomata, lichen and leukæmia (in which the white blood corpuscles are killed off by irradiation) have been successfully treated with *X*-rays.

In this connection we may point out that *X*-ray therapeutics can only be successfully practised when the characteristic radiations for certain treatments are definitely specified, and not merely the dosage required; hence it is essential that the medical radiologist should have a thorough knowledge of the physics of radiology.

(*f*) Optical Properties.

We have already seen that the intensity of the radiation follows an inverse square law, the same as in ordinary optics. The effect of these radiations on a selenium cell (variation of resistance) also follows the optical law. Moreover, in 1912, von Laue showed that these radiations cause interference patterns when they are transmitted through crystals, consequently the *X*—the unknown quantity—has been eliminated, so that we may

now classify Röntgen rays under the general heading of wave-motions.

This discovery enables one to determine the lattices of crystals as well as the distance between the atoms in the lattice of the crystal. Furthermore, by observing the variation in the intensity of the spots with variation of temperature one can estimate the kinetic energy of the atom at any stated temperature. The appearance of the spots, again, indicates whether the lattice of the crystal is ideal or flawed, and also whether the crystal is in the transition stage.

This method may be applied practically in testing and grading diamonds and precious stones.

Radio-active Substances.

Radio-active substances emit electrically charged particles, which constitute the so-called corpuscular radiations, as well as radiations after the nature of Röntgen rays, but the wave-lengths of the former are at the utmost one-thousandth part of the shortest known *X*-ray. These radiations, both ethereal and corpuscular, cause similar effects to *X*-rays.

In the application of radio-therapy, the corpuscular radiations probably functionate as the originators of a definite type of *X*-ray.

In general the emanation from a radio-active substance accelerates growth in plants.

The bactericidal action of the rays is similar to that of ultra-violet light, only the time of exposure must be longer.

Medically, the advantage of the emanation is that it may be absorbed by a fluid, and then injected into a strictly localised region. For this purpose liquid paraffin may be used on account of its high coefficient of absorption and its high viscosity, which causes it to remain for a considerable time at the infected area when it is injected.

(*Read, July* 4, 1917.)

Sugar Cane Wax.—"A considerable amount of attention," says the *Journal of the Royal Society of Arts*, "has been given in recent years to the recovery of wax from the waste produced in the extraction of sugar from the sugar-cane, and it is satisfactory to find that this industry has now been started on a small scale in Natal. Samples of the first consignment of Natal sugar-cane wax shipped to this country have been examined at the Imperial Institute, and have been found to be of good quality, quite equal to that of the first trial samples made and examined. Sugar-cane wax is now becoming better known on the market, and could be used as a substitute for the better known Carnuba wax in the manufacture of gramophone records, polishes, candles, etc."

SANSCULOTTISED LITERATURE IN FRANCE.

By Prof. Renicus Dowe Nauta.

The fraction of the eighteenth century French literature which it is my intention to consider in the present paper is the period during which a series of preparatory and partial revolts culminated in the final outbreak of the Revolution. I shall have to discard all regular and ordinary literature, boiling down my remarks to what might be called glimpses at French literature as sansculottized during the great social upheaval. I shall equally be debarred from drawing into the circle of my considerations any of the literary lions of the pre-revolutionary eighteenth century; nor even shall I dwell upon the works of poets like Marie-Joseph and André Chénier, the latter of whom fell a victim to the guillotine; Lebrun, the French Pindarus; Ducis, the translator (!?) of Shakespeare; Vergniand, the lyric; or on those of Pixerécourt, the originator of the modern French melodrama; Beaumarchais, the greatest of the dramatists of the time, author of the exquisitely witty twin-comedies "Le Barbier de Séville" and "Le Mariage de Figaro"; Mirabeau and Barnave, the orators; Chamfort and Rivarol, the moralists; Volney and Dupuis, the philosophers. I intend confining myself to a few outstanding and well-defined types: Hébert, Marat, Robespierre, Danton, Camille-Desmoulins. To show the corroding influence of the revolutionary neurosis on their mentality, and the various consequences accruing from it for their surroundings, will be my chief endeavour.

Buffon, in his famous "Discours," writes "Le style c'est l'homme"; and if any corroborative detail should be required to confirm the truth of this maxim, we have only to look for it in the literature of the great Revolution. The language of the people, that of the political leaders and zealots, as well as that of the journalists and orators of the time, is steeped in the most lurid hues; it is highly emotive everywhere, and representative of the various temperaments of each and everybody. Some brandish the whip of satire with never-flagging skill and energy of grasp; others pontificate in a most solemn manner, like so many divining augurs; others, again, give free scope to the most impetuous, the most fiery inspirations of their genius. It is through the medium of their words and the style of their writings that we are best enabled to judge the men of those times; it is by mentally resuscitating the sessions of their assemblies and the meetings of their clubs, by perusing the numberless journals, circulars, gazettes, and placards which were daily scattered broadcast over Paris with a sonorous, rustling flutter, that we succeed in understanding their most unimaginable decrees, their most extravagant incongruities, and that, after emerging from this mass of motley rubbish, we feel competent to realize the hugeness of the achievements of the Convention.

King Demos declines speaking anything else but the language of Billingsgate. What is the good of polite manners, of choice expressions, of severely strict syntax? All this is offensive in his nostrils and smacking of aristocracy. Perfect equality requires that one should express oneself without ceremony, and call a spade a spade, and that nothing remind one of bygone times of abject slavery, when one was forced to refine upon one's speech so as to please and flatter the great. And since it has appeared that his roaring oaths do agonize and sting the fair ci-devant to the quick, he makes it a point to raise his voice and bespangle his style with quite a number of those gems from the gutter. The picturesque is not precluded; far from it. When French stoops to be trivial, it becomes only so much the more flowery and parabolic and figurative. The figures are of the spiciest and the most indecorous—there is no doubt about that; but they are as a rule extremely droll and funny, with a ring in them that reminds one of the guffaw of Rabelais. The "esprit gaulois," cornered by Mrs. Grundy and whisked out of the drawing-rooms, where, not so very long ago, it was looked upon with genial complacency, had taken refuge with the people. And what a host of quaint metaphors do we find in the mouths of the sansculottes! The horrid tumbril of the scaffold becomes with them the "vis-à-vis de Maitre Sanson"; or "le carrosse à trente-six portières"; the guillotine receives the speaking name of "le rasoir national"; they even hurl their pitiless jokes at the woeful cortège of the condemned victims as they pass by, and shout: "Ils vont mettre la tête à la fenêtre," "Ils vont faire la bascule," "Les voilà en route pour essayer la cravate à Capet," "Éternuer dans la sac," "Demander l'heure au vasistas," etc., etc.

One man, of all others, bestirs himself to deal out and disseminate this semi-argot, of which the French populace are so fond. That man is Hébert, the editor of a scurrilous paper called *Le Père Duchesne*. His contributions to this publication were mostly sketches from real life and portraits after nature. He studies his models on the wharf and in the market-places, as Molière had studied his marquises at the Court, his medical characters in the boudoirs, his scholars in the haunts of learning. The paper became notoriously popular to a marvellous extent. Its "Lettres bougrement patriotiques," a title of which as a mild translation, this might be given, "Confoundedly Patriotic Letters," littered most ostentatiously everybody's table, even those of the most fervid royalists, whom they served as certificates for public-spirited civism. It was incontestably a stroke of genius in Hébert to create this original press, which was destined to ere long get the whip-hand over public opinion. There is no doubt but that it was greatly instrumental in bringing about the condemnation of Louis XVI, and later on that of the Girondins, whom Hébert used to style "ces crapauds du Marais." It was sufficient that the *Père Duchesne* burst into a passion—and this happened fairly often—to forthwith see a movement set on foot in favour of the measures which it either demanded or advo-

cated. While fawning upon demagogy it enabled the people by its lucid *exposés* to grasp the most abstruse political propositions, and it is not impossible that the day will come when it will be universally recognised that wit, originality, and eloquence—may be the *only genuine* eloquence of the Revolution—once centred in Hébert and in his abominable *Père Duchesne*. Nevertheless, this Hébert remains the most repulsively odious figure in the *galerie* of revolutionaries. The memory of even Marat does not appear so deeply stigmatized and so infamous as Hébert's. This is so because, with Hébert, everything is organized hypocrisy, frigid perfidy, and deliberate calculation. Well, we may be able to forgive a good deal of violence, but we cannot possibly condone tartufery. Hébert was an eloquent person, a fop and buck about town, and thoroughly well educated. For him the Revolution was not a means, but an end. If he had been born in the lower strata of the people, whose vile language he handled so deftly, we should not have had to upbraid him for having usurped their argot. But he was a refined aristocrat, and had nothing in common with his proletarian partisans. We may fairly compare him with those politicians who, on canvassing and on polling days, after shaking and squeezing the blackened hands of mechanics, rush to the washhandstand to soap off the smut. And yet as late as 1789 this Hébert was still a good man, inspired with the very best of feelings. Letters which he wrote to his mother and sisters in these days prove this to the full. What has made him odious to us is his political tergiversation and his time-serving defections. This infuriated caterer for the guillotine was once a militant Royalist, as may be seen from several complimentary snatches of poetry dedicated to the Queen, and from his lamentation on an occasion of an indisposition of Louis XVI: "Alack-aday, my pleasure is gone; my wine is like wormwood, my pipe is rank in my mouth! My king, my good, kinds king is ill! Frenchmen! if you have tears, prepare to shed them now with me." A few months later on this same beloved King became with him the ogre, the fuddled soaker, the churl, the swine, the cuckold Capet; and the adorable Queen the she-wolf, the tigress, the frivolous, spoony Austrian monkey! Indeed, it may be said that Hébert dived to the bottom of the well of infamy during his campaign against Marie-Antoinette, whom he persecuted with the ferocity of a hyena. The origin of the *Père Duchesne* is a curious one. This uncouth type had been a character well known among the theatre-going public. Some years before, in a popular farce, a certain potter and furnace-maker had been shown up on the stage who could not say three words without rapping out a shocking oath or other bad language. The groundlings in the pit and the angels in the gallery had been highly amused at the performance, and the silhouette of this old fogey, whose name on the cast was *Père Duchesne*, had remained popular as the incarnation of the sound common sense and the inveterate ignoble coarseness of the mob. Ever since 1789 his name had occasionally adorned political pamphlets.

And did *Le Père Duchesne* disappear along with his patron Hébert? By no means; in every troublous period in France he resuscitates, and just before the present war he was rendering yeoman service to the modern anarchists, under the name of *Le Père Peinard*—Old Father Drudge.

It is difficult to separate another contemporary paper, Marat's *Ami du Peuple,* from Hébert's *Père Duchesne.* But for a few exceptions they followed both the same line of politics, and if it must be acknowledged that they were not written in the same language and the same style, still, to the core they were the same. And yet, however odious and loathsome Marat may be, he does not deserve the same reprobation as his fellow-pamphleteer Hébert. What widely divergent psychology places these two neurotics at the opposite poles of the Revolution! The one with his *Père Duchesne,* the grotesquely sinister offspring of Jack Pudding, whose foot has slipped on clotted gore; the other with his *Ami du Peuple,* an ideologist of unbounded conceit and vanity, terrible jealousy, and morbid temperament, tottering on the brink of Bedlam, in which he is going to founder. In the series of historical neurotics and lunatics Marat ought to occupy the place of honour. Does he not himself acknowledge that he is in the grip of the delirium of virtue? But his delirium is the rage of persecution. Everywhere he sees none but scamps and scoundrels rebelling against the native country—that is to say, against *him*—and with indefatigable obstinacy, he claims their heads. He loves to proclaim himself a martyr of the Revolution; he revels in boasting of the sacrifice he is constantly making of his dear health and his life; and in reality, he is one of those rare champions who shirked the danger and hid themselves in the hour of peril! He keeps on raving about the ungrateful, frivolous rabble, for whose sakes he is sacrificing himself, and invariably, like the ogre of the fairy-tale, who claims his daily prey, *L'Ami du Peuple* demands the holocaust of anti-revolutionists—now 600 heads, now 10,000, now 20,000. Michelet, the great French historian, who has gone to the trouble of counting these homicidal claims, mentions a total of 270,000! Lamartine was kind enough to see in him "l'expression permanente de la colère du peuple." This diagnosis holds no water. Marat's case is barely and simply pathological, and a clinical one for the lunacy ward. Misfortune, or the irony of fate, has willed that the Revolution should take him seriously, instead of relegating him to the padded cell or pinioning him in a straight waistcoat. It is astonishing, besides, that the people did not get sick and tired of his uniformly monotonous and desperately prosy prose, when, without a shade of variety, he keeps doggedly harping upon the same string. Michelet expresses this characteristic beautifully when he says that Marat was like the irritating tinkle of a bell, one and the same bell that is being tolled incessantly and without a second's interruption. As for literary quality, in the *Ami du Peuple* we find the riff-raff lingo and style replaced by a language which, if not noble, is at least grammatically correct. This he has in common with the majority of the writers of his time, who, as a

rule, were not keen on revolutionizing syntax, and who were not afraid of being taken for aristocrats on account of their language being academic.

Through an unforeseen antithesis—the history of the Revolution is replete with antitheses—the parliamentary style is diametrically opposed to the language of the people. On the platform no triviality, no outrageous coarseness, no blasphemy. The orators are like so many "heavy fathers" expressing themselves in accordance with the all but exaggerated rules of rhetoric. Several among them being members of the Bar, they make it a point of honour to carry the palm of victory in those tournaments with the tongue that are held daily at meetings and clubs. Robespierre is the typical representative of these academic orators, whose wearying emphasis stands out in cruel contrast with the violence of their politics.

At the festivities of *prairial* (20th May-18th June), this pontiff of the Supreme Being was simply perfect as a pontiff; for such he was throughout his life. His speeches are homilies, his colleagues the catechumens, whom it was his task to convert. Virtue is his hobby. He does not deliver his harangues *ex improviso*. He carefully writes them down in the quiet seclusion of the study; he never takes liberties with the classical division of his addresses, and the sequence of exordium, proposition, proof, refutation, and peroration is conscientiously adhered to. To state it plainly, he has not a single one of the qualities of the political orator, whose fiery and spontaneous eloquence electrifies the mob, and who gets his inspiration on the spur of the circumstances. He was a sentimentalist, who had strayed into the whirl of the revolutionary cyclone. Without this cyclone Robespierre would in all probability have become a scrupulous barrister, a devotee of literature, whose mystic propensities would have found ample scope and gratifications in J. J. Rousseau's writings. As a youth he was a member of the *Rosati Club* at Arras, a club of young men united by the bonds of friendship and by a taste for poetry, roses and wine, who went in for philosophy—that is to say, who were following the movements set on foot by Rousseau and Voltaire. The majority of them sacrificed on the altar of the Muses, and so did Robespierre. Quite a posy of nice little pieces of poetry did he write, redolent with rustic country odours as Jean Jacques loved them, or scented with the perfume of old-fashioned amorous courtship. What a distance there lies between these innocent times and the day when he gave his absolution to Providence for the perennial rule of crime and tyranny on earth, or when he professed to make France the ornament of the universe! Of a nervous and bilious temperament, this utopian visionary, who firmly believed in the actual practicability of Rousseau's "Contrat Social," and yet swerved so far away from his master, was probably more than anybody else smitten with the circumambient neurosis. This originally trusty and straightforward mind—his addresses in the Legislative Assembly are available to

testify to this character—has gradually slid and deflected towards an aim which was diametrically opposed to the object he had in view at his starting-point. How true this is may be seen from the fact that in the opening days of the Revolution he strenuously moved the abolition of capital punishment. When Jacobin dictator, he has never been shunted along this wrong track consciously but he was logically bound to go on towards terrorism, which is, and for ever remains, *his* work. He was a sharply outlined revolutionary type, and had many imitators. His mysticism, his religiousness, the ideal of lofty morality that he believed himself called upon to incarnate, all this he has in common with a host of politicians who were all more or less disciples of Rousseau. Rousseau himself, however, would have disowned the slightest share in the Revolution at the very first drop of blood shed in its course!

Next to Robespierre, we invariably think of Danton. As an orator Danton is the incarnation of the French spirit. His eloquence was of a lively, passionate, thrilling, though sometimes incorrect, character, and flowed from the purest of sources. He refused to follow the fashion then rife among political orators, who, hypnotized by the constant contemplation of ancient history, could not address a meeting without duly alluding to Athens and Marathon, Lacedæmon and the Thermopylæ, Cato and the Gracchi. He is also free from the blame of bad taste that has to be laid so frequently at the door of his contemporaries, whether orators or journalists, republicans or monarchists, Montagnards or Girondins. With him no fustian, no overstrained, too florid images, no turgidity, no inopportune mysticism, but sound and limpid language, marking the brisk time of the march of the Revolution, or sometimes roaring like thunder in the hour of danger; a language which made the heroic enthusiasm of deep-rooted faith in the destiny of the native country ring out freely beyond the walls of the Convention. It would be easy to give sample upon sample of prose run mad in the mouths of all the political orators of the time. I have been able to discover only one passage of Danton's that is open to ridicule, and for curiosity's sake I will quote it: " Je me suis retranché dans la citadelle de la raison; j'en sortirai avec le canon de la vérité et je pulvériserai les scélérats qui ont voulu m'accuser." History keeps Danton and his lieutenant, Camille-Desmoulin, together. There is something in the latter's speeches that makes one inclined to believe that he was as brilliant an orator as he was a smart and clever journalist. He was not, being a stammerer. Besides, it is not as an apostle but as a writer that he exercised his greatest influence, and as such only his name has come down to posterity. As an author, he is chiefly known as the editor of the " Révolutions de France et de Brabant, and of the " Vieux Cordelier." He was the wit of the Revolution. Michelet playfully calls him " le polisson de génie aux plaisanteries mortelles"; de Montseignat alludes to him as the " gamin de Paris du journalisme." His pet foible was to sacrifice everybody and everything to his pleasure of being

satirical, and as a pamphleteer he wielded the whip of satire with elegant ease. He frequently made Paris split with laughter by the macaronic fancies—after the manner of Juvenal—which he popped off against those whom he wished to stigmatize. The first to be the target of his caustic sallies were the royal family; then came the turn of the aristocrats; then those who were the first to show fright at the progress of the Revolution; then those who wanted to check the revolutionary movement. In his turn Camille put in the last straw that broke the back of the opposition, when the King was to be sent to the guillotine, and finally, he attacked the Girondins. When he was informed that they had been sentenced to death, he swooned, exclaiming: "It is my book that is the cause of their death!" At a glance he now proved the abyss which was yawning at his feet, and into which so many good Republicans had already been engulfed, driven into it by that delirium of persecution which had laid hold of the least demented among them. Was it sincere remorse for having provoked the downfall of the Girondins? Was it a prophetic vision of the fate awaiting him? or was it that he loathed his own unwarrantable cruelties, that, in conjunction with Souberbielle and Danton, made him resolve to check the terrorists? Whatsoever it may have been, the shells fell from his eyes when it was too late to mend. "I feel sometimes," said Camille, "as if I could turn my pen into a dagger and stab the wretches? But let them beware! My ink is more indelible than their blood; it will stain for immortality!" "Well, then, if this be so, begin to-morrow," replied Danton. "It was you who started the Revolution; it is your duty to put on the brakes." But the sinister wheel was revolving with too great velocity to obey any brakes, and on the 9th thermidor it crushed the reckless demagogue who had set it going. Let us now leave the orators and journalists, and see what became of dramatic literature.

It says somewhere that the drama is a harbinger of the evolution of ideas and the pioneer of social emancipation, but that, whenever a political tempest breaks loose, it is carried along and tossed hither and thither by the terrible violence of the blast. Excellent for the purpose of justifying theoretical reform, the drama is incapable of controlling the practical application of the same; it is powerless against the unavoidable excesses accruing from a revolution, and unable to act as the moderating brake that is indispensable for securing the stability of equilibrium. It is kept in subjection by the events, and when no longer able to hold the leadership, it stoops to follow in the wake of triumphant demagogy. The history of the drama during the revolutionary period is a typical illustration of this theory. In proportion as the various political phases are developing, and the rule of liberty, progressively established, gradually degenerates first into despotism and then into terrorism, dramatic art shows a retrogression which daily becomes more and more noticeable, and finally results in a most lamentable bankruptcy.

Was this not exactly the opposite of what was naturally to be expected? In the face of the astounded world, the men of '89 and '93 had proclaimed the principles of renewed society; and in the soil of France, waging as she was the epic struggle for liberty against combined royalty, the mysterious flower called "patriotism" germinated. What more inspiring subject could there be for a poet than the glorious deeds of a new-born republic? What purer source for an artist to drink from than the one that was to regenerate the world and mankind? Alas, art also had to obey the law of antithesis, the law that proved so cruel and pitiless towards French genius. The effect of the Revolution on French literature was of a highly destructive nature. Many years before the outbreak proper, the barriers, which in the preceding century had been so carefully erected, had already been shaken and hauled down; a breeze of levellism had risen and mixed up pell-mell what formerly was jealously kept asunder. The drama, for example, instead of remaining what it then was, a work of objective and serene art, was turned into an implement of action and political propaganda. It is no longer the noble entertainment and diversion of a would-be élite: it must now be an enjoyment and an object-lesson accessible to all and everybody. Consequently, the authors, in order to please imagination of the audience, and stir their feelings, must cast about for appropriate novel subjects and expedients. This meant nothing less than a revolution in the history of the drama: a revolution not easily accomplished, for a host of deep-rooted prejudices, much ruffled self-love, hostile criticism, and, above all, the spirit of the times, had to be taken into account. Of course, this new popular drama did not supersede old tragedy at one fell swoop. Around tragedy, which itself had badly fallen into the sear, into the yellow leaf, but which was not yet dead, all sorts of bold novelties gradually arose: as, for instance, the amusing comedies of La Chaussée; the bourgeois dramas started by Diderot; the anodyne, virtuous harlequinades of Florian; and quite a torrent of comic, historical, pastoral operas, pantomimes and marionets, pieces full of childish fancies and of blatantly edifying morality, as some of the silly titles clearly show—"Le Voleur converti par la Dame Secourable," "Le Pardon imprévu de la Nièce malheureuse," etc. However, to make the popular drama rise victorious above these first pitiful and feckless attempts, a decisive, critical attempt was necessary. And that event arrived: it was the Revolution. In the average handbook on the history of French literature, it says that the period from 1789-1827, the year in which appeared the preface of V. Hugo's "Cromwell," is, as far as the drama is concerned, a period of barrenness, a mere blank. We get under the impression that, between the last tragedies of Voltaire and Ducis and the publication of the first pieces of V. Hugo and A. Dumas, no drama whatever existed except a few tame, soporific and colourless tragedies by Chénier and Luce de Lancival, and some paltry, ludicrous comedies by Etienne and Colin D'Harleville. This is

far from correct. At no time dramatic life was more active; however, we must not look for any productions in the superior, official styles. But in the lower regions of the popular styles we find a teeming growth of pieces, which are frantically applauded by a thoroughly plebeian public, who, not craving for refined, artistic enjoyment, only want opportunities for giving free scope to their imagination, and for ventilating their feelings. This kind of public had been in existence ever since the last years of the "ancien régime," when it made itself gratefully instrumental in securing success to the dramatic productions of Diderot, Mercier, and Florian. During the Revolution this public, emancipated by the "Declarations of the Rights of Man," comes rushing in crowds to the theatres, where it eagerly tries to find the realization of its dreams and the gratification of its instincts. For their benefit, additional playhouses arose. By the side of the venerable Comédie Française—the House of Molière—theatres like Les Italiens, La Foire, Les Variétés, L'Ambigu, Les Grands Danseurs, Les Beaujolais, were started. After the decree of 13th January, 1791, on the strength of which the Constituante gave entire "liberty with regard to theatricals, playhouses sprang up like mushrooms, and we find "Le Théâtre de la Nation, that of La République, Les Gaietés, Le Vaudeville started into life. And what are the pieces like, destined to shine on all these new stages, especially those of the Boulevard? They are specimens of the genuine plebeian drama—I mean the melodrama and the vaudeville, which is nothing but a melodrama in the lighter comic vein. Unfortunately, among the numberless dramas staged between 1790-99, there are scarcely any which it is worth our while to record. And yet never were dramatists more prolific than in those years. But what store we may set by these gawky productions is amply shown from the scathing contemporary criticisms. And yet these burlesque and hideous pieces, showing up, after the ignoble taste of the day, the exaggerations exhibited in the streets, the excesses perpetrated by the committees and clubs, were daily applauded by a delirious public. Next to these, and equally scurrilous, was the anti-clerical drama. The Revolution had sanctioned the overthrow of the Roman Catholic faith, and with the worship of this "Déesse de la Raison," all priests were pounced upon. The "Supreme Being" had no use for "calotins" in surplices and stoles. These distressing scrawls have one characteristic in common with the former, and that is monstrously bad taste. Then there were a third and better sort, the patriotic and republican apotheosis. Society was in the grip of a mystic kind of enthusiasm, and this state of mind was reflected in a disastrous manner on the stage. Usually the latest feat of arms was represented—the taking of Toulon, the Siege of Lille, and others. Talma, the great actor of Napoleonic memory, advocated a return to antiquity, and thus Miltiades, Manlius, Torquatus, Mucius, Scævola, Brutus, *e tutti quanti*, could now be seen strutting the boards. Worthless as these stunted epopées may have been, they

were at any rate a school for civism to the public, and succeeded in steering clear of hideousness. They were equally devoid of the æsthetic element as the two preceding ones, but literary beauty was neither required nor expected. To prove this we need only quote a fourth class of sansculottized dramas, which were nothing but ruthless and unwarrantable travesties of the works of the great classical dramatists. One of them is an attempt at foul murder of Racine's "Athalie," in which some scenes have been mixed up with dislocated shreds of Molière's "Malade imaginaire" and "Don Juan," and which the public greeted with outbursts of all but uncontrollable merriment. It would be unfair not to mention the theatre of the opposition, which was a good deal superior. How could it be otherwise? The French are naturally oppositionists—*frondeurs*, as they call it—and, whichsoever their political regimen, they will always display a much stronger proclivity to disparaging their rulers than to currying favour with them. This is quite complimentary to the French; for if, at any time, it is a manifestation of pluck to challenge and harrow the party in power on the boards, in the days of the Revolution such pluck was sheer heroism. Laya and Neufchateau, the former with his "Ami des Lois," the latter with his "Pamela," dared to put the cause of liberty before the aristocratic public of the "Comédie Française." In the "Ami des Lois," Robespierre was impersonated by the character of Nomophagus or Laweater, and Marat by that of Duricrane or Flintpate, and both get very hard truths hurled at their heads. The usual public of this theatre consisted of lukewarm revolutionists, and they encouraged on the sly the efforts of certain actors, who, after cutting themselves adrift from Talma, Dugazon, and the other patriotic colleagues, did not shrink from organizing a systematic opposition to the new regimen. The performances of both these pieces gave rise to such tumultuous scenes in the house that the "Comédie Française" printed at the foot of the programmes: "By order of the municipality, the public are informed that it is strictly forbidden to bring sticks, cudgels, swords, or any other weapons." Better than any argument, this notification proves that the theatre, like the clubs, had been transformed into the cockpit of the parties. This was, however, not the fault of these pieces.. What the public wanted was to deal blows anyhow and regardless of what the actors were performing on the stage.

"L'Ami des Lois" and "Pamela" were decidedly superior to the numberless pieces of the time. They were not tinctured with the extravagant mysticism that characterizes the revolutionary mind; they do not preach any new gospel, whether that of *Reason*, of the *Native Country*, or of *Liberty*. Their sensible language was not the language of either sectarians or rowdies. Revolutionary fanaticism as shown on the other side was not a whit better than the inquisition of the Middle Ages: the disciples of Rousseau and the successors of the encyclopædists, badly guided and insufficiently emancipated as they were, made a calamitous

application of the principles and maxims of their respective masters. What may have been the cause of this bankruptcy of the dramatic art during the Revolution? Its cause seems to be narrowly connected, first with the conditions claimed by the public, and secondly with the interference of the rulers with theatrical affairs. Public opinion and censors were here responsible for this prostration of the drama, of which only the powerful influence of the romantic movement has been able to cure it. The spectators were no longer the placid ladies and gentlemen of yore, who used to come to the theatre to spend a couple of enjoyable hours and for a relaxation of the daily routine of business. With the Revolution *politics* entered the theatre as it did everywhere, and ere long it completely bossed the place. It became an obsession. The citizens forcibly connected everything with the revolutionary principle; the words of the "Declaration of Rights" were dinning in their ears like the burden of a war-chant. They were on the verge of the rage of persecution. Anyone who evoked the slightest remembrance of the tone, the spirit, the manners and customs of the *ancien régime* of "former thraldom" became suspect. We have seen before how firmly this same form of insanity had gripped the caterers for the guillotine. The sansculottes prick up their ears at the first word they do not like; they rise, shout, bawl, order to actor to retract his words, and only settle down again when what they call justice has been done and the principle is once more safe. The busts of *Marat* and *Lepeletier,* those *glorious* (!) *victims* (!), who fell under the knives of monstrous assassins, are put on the proscenium. The name of the theatre, which was an aristocratic one, is changed into that of "Théâtre des Sansculottes." At the same time, the "Comité du Salut public" ordered that on certain days of the month free performances should be given for the benefit of the people. None but the genuine patriots, wearing a certain badge, were to be admitted. Thus the Revolution revived the ancient Roman *panem et circenses!* Besides, censors dominated the theatres, who gradually succeeded in republicanizing and sanscullottizing Corneille, Racine, Molière, and even Voltaire, who were unscrupulously mutilated and disfigured. Sometimes these censors vetoed entirely the performance of a certain piece. Among others, Beaumarchais' "Mariage de Figaro" became the victim of their evidently thoughtless ostracism. The fact is hardly credible, since the Revolution ought to have honoured this comedy as the prophetic harbinger of the new idea! Beaumarchais' name occurs on the eve of the Revolution, and is important both from a point of view of literature, and as a sign of the coming storm. His "Figaro" is one of the great creations in French comedy, and a lineal descendant of "Panurge" and "Scapin." In the "Mariage de Figaro" the hero is simply the mouthpiece of the author's second-hand revolutionary ideas. So this amazing prohibition is a proof that the revolutionary neurosis was complicated with a conspicuous perversion of the critical sense. From its opening to its closing

scene the "Mariage" puts the vanity of human greatness on the pillory, and levels a Spanish grandee down to being the absolute equal of a mere barber. *O lippi et tonsores!*

To conclude, I should like to say a few words about the poetry of the Revolution. As a rule, the poetry of a given period symbolizes fairly well the character of that period, and reflects more or less faithfully the mentality of society. Under the Sun King, poetry is of a solemn cast, and gracefully moves along in stately strains to the formal rhythm of its alexandrines. Under Louis XV. and de Pompadour, it babbles and chatters merrily and prettily, playing its waggish quips and cranks in the salons, the *réduits*, the *ruelles*, and *alcoves*. With Marie Antoinette it affects almost virginal candour and unadorned simplicity. It is then the heyday of little white and woolly lambs, with pink and light blue ribbons. Jean Jacques imposes the sentimentalism of his "Nouvelle Héloïse," and the educational principles of his "Emile," which subsequently suggest to Mme. de Genlis her dull and tedious twaddle, and to the Abbé Barthélemy the soporific peregrinations of his young Anacharsis. Contemporarily, again, a goody-goody kind of descriptive garden poetry buds forth in the flat and unprofitable "Georgics" of the gentle Delille. Practically all this means already revolution of the salons, of the manners, of the fashions. Philosophy supersedes the frivolous, sappy tittle-tattle, of which our modern flirting societies remind us sometimes. The time is almost ripe for a sweeping change in regimen, in manners and morals. As early as 1783 Lebrun-Pindare had published an "Ode," in which he demands the demolition of the Bastille. Lesser poets began to forestall new times. They sang the unpleasantness of royalty, but not daring to lay the fault on Louis XVI, they made Frederick II. of Prussia their scapegoat. Louis XVI. did not hear Lebrun's categorical appeal, and on the 14th of July, 1789, the mob took the matter in hand, with the result we all know. Since then the popular Muse had no end of the choicest pabulum to feed on, and this 14th of July was sung and celebrated and solemnized in a hundred various strains. There was no revolutionary event, however small, of which poetry did not make its prey. It assumed all manner of forms; it was epic, lyrical, and didactic at the same time; it was original, extravagant, fantastical, eccentric. Sublimity in it walked hand in hand with platitude. In one inspiration rises to the very pinnacles of Parnassus; in another it grovels in the dust like a whipped dog. One versifex of the time got it into his head to write:

"La liberté d'écrire enfante le génie!"

and hundreds of petty prosy gradgrinds, deeming themselves suddenly gifted with the divine afflatus, set to work and became in their own eyes as many Pindaruses. The national and civic festivities especially gave rise to sheer torrents of poetry, and the feast of the *Fédération* inspired a swarming host of troubadours. On this memorable occasion no fewer than 4,200 poems

were composed! Need I mention that, with the exception of a few happy lines and some ideas worthy of the Muse, there is absolutely nothing to be found in this farrago but the traditional banality of topical verse? In the meantime, after the success achieved by his "Charles IX.," Marie Jos. Chénier, the official poet of the Revolution, had finished his famous anthem, "Le chant du Départ"; Lebrun, Mercier, Neufchâteau and Laharpe had rhymed, more or less felicitously, a number of odes, some of which are very fine, others most silly and insipid. It is generally believed that the song which first fired revolutionary enthusiasm into a paroxysm was that well-known dithyramb of Rouget de l'Isle, "The Marseillaise." This is not quite correct. It was another poem, entitled "Le Salut de la France," that did it. This piece was composed by Roy in 1791, after an aria of one of the operas of Dalayrac. Its popularity was instantaneous and immense, probably on account of its simple and easy harmony. In 1792, on the eve of the declaration of war, the Mayor of Strasburg ordered one of the officers of the town, one Rouget de l'Isle, to compose a chant with which to rouse the martial enthusiasm of the soldiers during their march to the field of battle. Rouget set to work, and in one single night composed what he entitled "Chant de guerre de l' armée du Rhin." It had a marvellous success. The battalion of Barbaroux took it for its national anthem, and so it became the anthem of the "Marseillais." At Marseilles it was sung in public by one Mireur, one of the *fédérés,* and published the next morning in the papers. From Marseilles its fiery stanzas promptly crossed over to Paris, where it was forthwith received as the first war chant of the Republic.* It has been frequently contended that Rouget is not the author of the "Marseillaise," and what the various critics wanted especially to deny him was the honour of having composed the tune, which is incontestably more original than the lines. The Germans have claimed the merit of it, alleging that it was plagiarized from the musical works of one Holtzmann, a German precentor!! Others asserted that it was taken from an oratorio by one Grison. But really and truly, the entire work, music and words, is by Rouget and by nobody else. Out of his numerous poems, poor fellow, this is the only successful one, but then it is his. In our modern eyes, it now incarnates the republican ideal; the author meant to make it chiefly a national anthem and a war chant. However, to be merely such, it is too much impregnated with the shibboleth of the Revolution, and abounds too much in expressions and words, fancied by the orators and hotspurs, who believed in the powerful charm of the word over the enthusiasm of the mob; words like "bondage" and "fetters," "despots" and "thralls," "tyrants" and "bloodthirsty tigers."† In spite of its blemishes, in spite of its rather bombastic style and thick metaphor, this

* Think here of what has happened to "It's a long way to Tipperary."
† How well does it fit in the frame of the present war!

poem sometimes verges on the sublime; take for instance, this stanza:—

> "Amour sacré de la patrie
> Conduis, soutiens nos bras vengeurs
> Liberté, liberté chérie
> Combats avec tes défenseurs!"

Or this, which is so appropriate in our days:

> "Entendez-vous dans nos campagnes
> Mugir ces féroces soldats?
> Ils viennent jusque dans vos bras
> Egorger vos fils, vos compagnes! . . ."

As for the tune of the "Marseillaise," it is extremely original. The opening bars sound like the echo of the step of soldiers charging at quick time, and this impression becomes gradually more accentuated as the lines roll on; and when the burden in its simple grandeur rings out like the report of a big gun, the soul of the "doux rays de France" and of the Republic vibrate in unison with these high-sounding notes. Rouget is the only poet that has produced a masterpiece, directly due to the powerful blast of the Revolution. This does not take away a whit from the fame of André Chénier, who was really a great poet, which Rouget was certainly not, but who owes his glory not to his revolutionary poetry, but to his incomparable "Elégies." To conclude, we find still some of that specifically plebian poetry which, without caring about any rules or regulations, is enthusiastic, satirical, and sometimes rich in lucky hits. It is the typically French ditty, the "chanson." In France, even nowadays, every feeling is ventilated, everything is rendered and voiced in "chansons." There appeared chansons on the Constitution, on the civic oath, on the rights of women, on the king, on the new calendar; even the scurvy Père Duchesne resuscitated singing his "chansons bougrement patriotiques," full of lively picturesqueness and unexpected images. Neither Marat nor Robespierre have escaped the tricks, sleights, and arrows of the popular Muse. The chanson pounced upon everybody and everything; even under the hatchet of the guillotine, sarcastic refrains were hissed forth. The poetical inheritance of the Revolution that has come down to us is immense in bulk, variegated in substance, and trifling in its intrinsic value. It seems that powerful, social shocks tend to dull and disconcert the inspiration of the poets, in the same manner as the formidable voice of the tempest drowns the chirp of the cricket.

"L'esprit gouverne, et la matière est gouvernée," says Thiers in one of those lapidary sentences of his, in which he meant to sum up his conception of philosophy. An assertion as dogmatic as this may find a place in a treatise on pure psychology; in a history of the French Revolution, it seems to be singularly out of season. It is a conclusion diametrically opposed to the one which Thiers would have arrived at if he had

endeavoured to define the psychological, or, rather, the psycho-pathological, element of society between the years 1789-93. If he had instituted an inquiry into the mentality of that society and determined the factors of its actions, he would have agreed that man has only a mere illusory power over the course of revolutionary events, to which he has to submit without being able to either control or direct them. Never, in literature as well as in everything else, the spirit was less of a ruler and more of a slave to inexorable and inevitable laws than during the period of the Revolution, when society was suffering on one hand a notable diminution of its intellectual faculties, and in the other manifested an appalling exaltation of the primitive instincts, by which it was kept tossing to and fro on the lumpy sea of violent and reckless passions and impulses. Summing up now, we may say that the effect of the Revolutions on French literature was absolutely annihilating. The reading public had for two centuries running practically consisted of the Parisian "beau monde." With the destruction of polite society, no educated reading public was left. It is true that the literary output during the Revolution is immense, but it consists almost entirely of pretentious rubbish, intended to appeal to an excited mob full of vague ideas as to the exalted virtues of antique republicans and the abject vices of antique and modern monarchs. It may seem strange that so momentous a period should have been so barren in literature, but one of the most striking features of the French Revolution is the almost ludicrous disparity between the greatness of its movements and the littleness of its men.*

(*Read, July* 3, 1917.)

THE WAR AND THE WEATHER.—The writer of the "Notes" in the *Journal of the British Astronomical Association,*† replying to a criticism by Mr. W. Campbell, of the theory that artillery firing affects the weather, says, "Probably Mr. Campbell has not been in the close vicinity of a modern bombardment, or he would realise that the disturbance of the atmosphere is considerable. Is it not probable that electric action is set up by the concussions of the firing, by the passage of the projectiles, and by the bursting shells? If the atmosphere is near the point of saturation it is likely that precipitation will follow, but if not, the disturbance may travel away until it arrives into a region of favourable conditions, and there upsets the balance. It is pretty well understood that bad earthquakes are followed by immediate heavy rain."

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* Ernest Weekley, "French Literature."
† 28 (1917), 77.

TRANSACTIONS OF SOCIETIES.

CHEMICAL, METALLURGICAL, AND MINING SOCIETY OF SOUTH AFRICA.—Saturday, September 29th: G. Hildick-Smith, B.Sc., President, in the chair.—"*Electric furnace manufacture of shoes and dies on the Witwatersrand*": Prof. G. H. **Stanley.** About 7,500 tons of stamp battery shoes and dies are required annually for the purposes of gold milling on the Rand. A committee was appointed two years ago to consider the possibility of manufacturing these articles locally. The report favoured a method of melting the large existing accumulations of old shoes and dies, amounting to several thousands of tons, in electric induction furnaces. A description was given of the subsequent installation of the plant and its operation and costs thereof, of the method of pouring and casting, and of the products turned out.—"*Electric steel-melting plant*": Prof. W. **Buchanan.** A description, from an engineering standpoint, of the plant used on the Rand for the production of shoes and dies, particular reference being made to certain special features of the design and construction."

Saturday, October 20th: G. Hildick-Smith, B.Sc. (President).—"*The application of diaphragm pumps to metallurgical work*": L. B. **Eames.** The principal use of the pumps in metallurgical operations has been in counter-current decantation plants for controlling Dorr thickeners and transferring pulp between them. A thicker and more consistent underflow can be secured by means of it than by any other means hitherto tried.

Saturday, November 17th: G. Hildick-Smith, B.Sc. (President), in the chair.—"*Fertilisers*": A. **Baguley.** The author discussed fertilisers in their relation to other factors contributing to increased soil productivity, and as a means of supplying the soil with essential plant-food constituents; the need of care to be exercised in certain respects lest fertilisers should bring about infertility was pointed out, and the sources and special functions of the various classes of fertilisers and of their several constituents explained.—"*A new method of determining copper.*": Dr. J. **Moir.** A quick process of obtaining the metal or ore in a condition suitable for determining the copper was described. To the copper solution so obtained excess of sodium thiosulphate is added, and potassium sulphocyanide, and the solution is titrated back with iodine.

Saturday, February 16th: H. A. White (Vice-president) in the chair.—"*Notes on an underground spring of water containing manganese and lithium*": J. **Watson.** The water was derived from an underground spring on the east drive of the City and Suburban Mine, Witwatersrand. It contained 178 parts of inorganic solids per 100,000, whereof 4.44 consisted of manganous oxide and .23 of lithium.—"*The manufacture of crude sodium manganate for use on the mines*": F. **Wartenweiler.** In view of the shortage of easily soluble oxidisers, this compound was prepared in order to replace the nearly pure potassium permanganate formerly used on the Rand Mines. It was prepared from pyrolusite from the Pretoria district, containing 40 per cent. of manganese, by heating 1 part of the ore in a furnace with 1.44 of caustic soda. No attempts were made to prepare a refined product, as the crude manganate can be substituted on the mines for all services for which formerly the refined potassium permanganate was used. It is more soluble than bleaching powder, and easier to handle and control. When once dissolved, and converted to permanganate by dilution with water, it is comparatively stable.

PAUL DANIEL HAHN.

PAUL DANIEL HAHN,

M.A., Ph.D.

(*Born January 5, 1849, Died March 9, 1918.*)

The University of the Cape of Good Hope was incorporated by Act of Parliament in 1873; on the 2nd April, 1918, it will be resolved into three separate Universities. During the 45 years of the parent university's existence its affairs were administered by seven successive Councils, and of the 31 members of the first Council, Paul Daniel Hahn alone survived to occupy a seat on the seventh.

Prof. Hahn was a South African by birth; he was born while his father, the late Rev. J. S. Hahn, of the Rhenish Mission, was stationed at Bethany, Great Namaqualand: the mission station is referred to in Frances Galton's "Narrative of an Explorer in Tropical South Africa." About 1853 his parents returned to Germany, and so it happened that young Hahn received his early education in the Gymnasium of Soest, in Westphalia.

In 1870 he passed his "Abiturienten" examination, and proceeded to the University of Halle, where he studied chemistry, physics, mineralogy, and mathematics, and subsequently acted as assistant to Prof. Girard. In March, 1874, he graduated as Master of Arts and Doctor of Philosophy, his thesis for the doctorate comprising two papers, which were subsequently published in the Proceedings of the "Naturwissenschaftlichen Gesellschaft" of Halle, 1875. The papers were entitled respectively "The phosphorescence of minerals" and "The chemical constitution of natural silicates." During these years Hahn's studies were mainly devoted to the physics and chemistry of minerals, and much original investigation was carried on by him. Of this period a monument remains in the magnificent collection of minerals—many of them South African—which he gathered together in the course of a long and strenuous scientific career, without doubt the finest private collection in the country.

In October, 1874, Dr. Hahn passed the examination whereby he ever afterwards set most store—the "Staats Examen" (*pro facultate docendi*), which gave him the right of lecturing in any German university. A month later he proceeded to London and to Edinburgh for further study, and, in a remarkably short space of time, not only familiarized himself with the English system of chemical nomenclature, but also widened his knowledge by gaining a close practical acquaintance with British methods of scientific work and research, and generally with university institutions in the United Kingdom. An incident is related of him during his stay in Edinburgh which reveals the innate kindliness of his nature. While attending a football match he witnessed a fatal accident on the playing field; this produced in him such a revulsion of feeling that he ever afterwards felt a dislike for the game.

September, 1875, found Dr. Hahn back in South Africa, and within four months of his return he had assumed the chair of chemistry at the South African College; his appointment was, in fact, made on his 27th birthday. Hahn's assumption of that chair, like his regretted vacation thereof through death, was almost coincident with a radical change in the educational system of South Africa: the University of the Cape of Good Hope had just received its charter, and had replaced the old Board of Examiners; Prof. Roderick Noble, Professor of Chemistry at the South African College, had been elected by the newly-formed convocation as a member of the University Council, but had died after a little more than a year's tenure of the latter office, and so it came about that Prof. Hahn, a few months after his return to South Africa, was elected a member of the first Council of the Cape of Good Hope University. On each subsequent occasion he had been re-elected, and had therefore at the time of his death held his seat on the University Council continuously for 42 years. His occupancy of the chair of chemistry at the South African College has thus spanned practically the entire period of existence of the Cape of Good Hope University, from near the start to the finish. For 27 years Prof. Hahn remained the sole direct representative of chemical science on the Council of the University, until he was joined, in 1903, by Mr. J. Martin, at that time Professor of Chemistry at the Diocesan College, Rondebosch.

Prof. Hahn began his work in connection with the South African College in a tiny room called a laboratory by barest courtesy, and from the very start his lectures were characterised by three outstanding qualities, systematic arrangement of subject, lucidity of explanation, painstaking attention to detail. In addition, he ever evinced the utmost patience with any student who failed to grasp some point in either a verbal exposition or a practical experiment, and never shrank from a step-by-step repetition of any obscure phase in a lecture, or of some involved calculation. These were the qualities that made Hahn's lectures so attractive and successful. A former student of his, who afterwards "sat under" the late Sir William Ramsay, the eminent discoverer of argon and the other inert gases in the atmosphere, said that although Ramsay excelled as a manipulator in experiments of extreme delicacy, he could not touch Hahn as a lecturer. The latter's gift of infusing a charm into his subject was rarely equalled, even when his audience consisted of boys three years below matriculation stage, to whom the educational system of the seventies and eighties compelled him to lecture. He possessed a special knack of imparting to students exactly the mental pabulum suited to their particular capacity. Once when he found an enthusiastic young student endeavouring to supplement the notes of his lectures by studying a treatise in advance of his years, Hahn told the boy that "milk from two cows at the same time is not good for a child."

Hahn had not occupied his chair many years ere his person-

ality—ever remarkable—and persuasive powers drew a substantial endowment from Mrs. Jamieson, and the outcome was a new chemical laboratory at the College, which was opened on the 1st June, 1881, Hahn himself assuming the title of Jamieson Professor of Chemistry. Thus satisfied, for the time, as regarded his own requirements, Hahn sought for wider fields of action. He began urging the erection of physical laboratories, and, accompanied by Prof. C. E. Lewis, to whom the suggestion of the tour was due, visited Kimberley and Johannesburg for the purpose of supplementing the amount they had already collected in Capetown for the proposed buildings. At Kimberley they were gratified by the receipt of £300 from Mr. Rhodes towards the scheme. At both centres they met with hearty support, and were back in Capetown within a fortnight with their task accomplished, and the sum of £5,500 secured for the building and equipment of the existing Physics Laboratory of the South African College.

By this time other fields of activity had begun to be worked. Hahn loved to encourage any movement that in his opinion tended to the advancement of South Africa (it was one of his favourite sayings that there is only one Table Mountain in the world, and only one Capetown in South Africa), and the two directions in which he saw openings for such advancement related to mines and to agriculture. He was ever indefatigable in exertion, and for many years after his appointment as Professor he habitually travelled about the country during vacation time, often with numbers of his students, the development of the economic resources of the country, especially of agriculture and more particularly of viticulture and tobacco-growing, claiming his chief attention; students and farmers were alike instructed during these excursions, not only by Prof. Hahn himself, but by mutual intercourse. Thus the agricultural trend of Dr. Hahn's sympathies began to make itself felt in the country's affairs: he served on more than one Government Commission to enquire into the condition and possible improvement of colonial viticulture, and in 1882, when *Phylloxera vastatrix* threatened to destroy the country's vineyards, he was associated with the late Hon. J. H. Hofmeyr in acquiring Groot Constantia for the Government as a model viticultural farm, and as a nursery for American vines, when the denuded vineyards might be reconstituted with suitable cuttings.

On more than one occasion, when the necessity arose for obtaining the services of an expert to deal with emergencies of the above character, the Government appealed to Dr. Hahn for advice, and thus he had a considerable share first in the inauguration of agricultural instruction at Victoria College, Stellenbosch, and subsequently in the establishment of the Cape Colony Agricultural Department. Throughout his life he continued to manifest this keen interest in the agricultural progress of South Africa, and the recent establishment of agricultural faculties at the Pretoria and Stellenbosch Colleges was neither more nor less than Dr. Hahn had advised.

Another outcome of Hahn's energy is the South African School of Mines and Technology at Johannesburg. In the *South African College Union Annual* for December 16th, 1890, he wrote a lengthy article urging the establishment of a School of Mines in South Africa, and setting forth in detail the value of such an institution for the country. Some three years earlier the Witwatersrand area had begun to be developed, and an increasing number of applicants for instruction in the chemistry of metallurgy and assaying had presented themselves at the South African College. All this while the fact that the mining industry of South Africa was wholly dependent on foreign mining engineers was being strongly borne in upon Hahn. With his usual persistency he pressed the need upon Government and upon all influential persons with whom he came into contact, until at length a working scheme was put forward with a course of instruction originally divided between the South African College and two Schools of Mines, one at Kimberley and one at Johannesburg. The present South African School of Mines and Technology at Johannesburg is the lineal descendant of those.

Up to this time Prof. Hahn had been the sole analytical and consulting chemist in the country, and not only Government chemical work of all kinds, but also that emanating from private persons, had converged to his laboratory. It was on his recommendation that Government chemical laboratories were established in Capetown, one in the Geological Surveyor's office and the other in the Agricultural Department; one of Hahn's pupils, the late Mr. J. C. Watermeyer, was appointed to the charge of the former, and another pupil, Mr. S. B. Morgenrood, to the latter. After a few years the two laboratories were amalgamated under Dr. C. F. Juritz, also a pupil of Hahn's, while four years later the chemico-legal and toxicological work which Hahn had until then continued to perform for the Government was likewise taken over by the Government's own laboratory, which had by that time been thoroughly organized and equipped.

About this period Hahn's popularity as an extra-mural lecturer on chemistry at the Good Hope Seminary (Girls' High School) led to an application on the part of two young ladies to be admitted to the College chemistry classes. Quick to recognise this innovation as a step in advance, he moved in the matter in the College Senate, with the result that to-day ladies form a most important section not only of the Chemistry Department, but of all the College faculties and classes. And now this same popularity began to manifest itself in another direction. The old laboratory building became much too small; classes numbering often over 100 students each, and sometimes exceeding 130, were inconveniently cramped in the lecture theatre and the practical work of students hampered in the laboratory proper, and so, twenty years after its erection, the building had to be more than doubled in size. Another period of thirteen years has since passed, and the need of expansion has once again been felt. To provide the requisite accommodation the old College

Hall has just been equipped as an additional laboratory, but the old professor's chair knows him no more.

Outstanding alike in physique, in personality, and in energy, and never failing in cheery optimism, Hahn sustained the burden of teaching a constantly increasing number of students unaided for 28 years. Only then did he admit the need of assistance, and Dr. H. Tietz, another of his former pupils, was appointed as an additional lecturer. This appointment, coincident with the enlarging of the laboratory, enabled Hahn thenceforth to confine his lectures to inorganic, applied, and agricultural chemistry. This change, too, enabled Hahn to revisit Europe, after a lapse of exactly thirty years, and he took the opportunity at the same time to attend the International Congress of Applied Chemistry in Rome in 1906. He had previously, in recognition of his long and devoted services in the cause of education, and more particularly in aiding the progress of science, been awarded the title of "Royal Prussian Professor" by the German Minister of Education.

One of the latest achievements of Prof. Hahn's energy is associated with the comparatively recent inauguration of a Medical School in connection with the South African College.

Amongst the other extra-collegiate movements for practical education in which he co-operated may be mentioned the South African School of Forestry established by the Cape Government. He took a prominent part in drafting its syllabuses, and in this connection instituted special chemistry courses at the South African College.

Hahn was a passionate lover of music, both vocal and instrumental, and was an enthusiastic and active supporter of the classical chamber concerts that used to be held in Capetown a few years ago. He was also for some years a member of the Music Committee of the Cape of Good Hope University, and founded a musical society amongst the South African College students.

The generation that knew Prof. Hahn in the zenith of his activity has long ago passed beyond the years of studenthood, for it had been his boast that he had taught fathers and sons, but hoped to retain his chair until he had taught the grandsons. To that generation his versatility had been a matter of common knowledge. In the earlier years of his tenure of office he used to lecture not only on chemistry, organic, inorganic, agricultural and analytical, but likewise on mineralogy, metallurgy, and physics. The wide range of his scientific knowledge is shown by the immense diversity of subjects on which he was often asked to advise or report. Before his assumption of office chemistry had been practically unknown in South Africa, and it is not too much to say that with his advent there dawned for the whole country an era of fuller realization of the value, not alone of chemistry, but also of science in general—an era of more intimate acquaintance with the nature of science, of fuller

understanding of its functions, of more thorough perception of the best methods of turning those functions to account.

Hahn seldom wrote, he seldom spoke in public, but he possessed the faculty of impressing the men students who passed under his hands—they must have aggregated some thousands—with an indelible sense of the importance of chemical science for a nation, and this sense has stimulated the scientific spirit in adolescent South Africa as no other agency could have done, for to all his former students Hahn was the outstanding link between them and their *alma mater*, and their scattering over the length and breadth of South Africa meant spreading far and wide the influence of the College laboratory, an influence that transcended the limits of chemistry, and even of science in its widest connotation. For example: one of the virtues that he ever strove to inculcate, both by precept and example, was punctuality. "The sun has never once caught me in bed," he often said, and during very many years he never missed a single lecture. Two bells, with an interval of five minutes between them, used to call the students to their respective classes: Hahn invariably locked the door of his lecture theatre on the stroke of the second bell and straightway commenced to lecture. On one occasion it happened that when the second bell was struck only one boy—now one of the most distinguished metallurgists on the Rand—had taken his seat on the benches, but, true to his principles, Hahn at once locked the door and delivered the entire lecture which he had prepared, inclusive of carefully thought-out experiments, to this solitary student, in exactly the same way as he would have done had the whole of his large class been present.

Reference has been made above to Hahn's great capacity for taking pains with his students. At one time his class for one of the highest degrees then at the disposal of the University consisted of a single student. This one student was regularly lectured to on all branches of chemistry—the lectures might more properly be called chemical discourses—and often they were given after college hours in the study at "York House"; book after book on every branch of chemistry, in English, in French, in German, was lent to this student, with the important passages specially marked; and beyond all this, the student was required to deliver a course of experimental lectures in inorganic chemistry, the audience consisting of the Professor alone. Every possible help was given by the latter in preparing the requisite experiments for each lecture, but when the time for delivery of each lecture arrived the Professor was suddenly transformed into an intelligent, questioning student, ostensibly ignorant of the subject, and keenly athirst for information at every point. This brings out not only Hahn's efforts to lead his students to independence of thought, but also his way of rousing enthusiasm amongst them for acquiring and propagating chemical knowledge. He could never divest himself of the consciousness, even after the lapse of years, that they had once been his students; this had a twofold out-working. It follows as a matter of

course that he maintained an interest in the subsequent careers of all his old students, and to those who visited him in after years he was invariably hospitality itself. Two incidents illustrate another aspect of the same characteristic. During the McArthur-Forrest case—one of South Africa's *causes célèbres* —Hahn was being cross-examined by one of his former students —by that time a distinguished barrister, to-day an eminent judge. "But, Professor Hahn," urged counsel, "is not ferrocyanide of potash a cyanide?" "Mr. X," replied Hahn, in a tone of reproach, "I did not teach you that." On another occasion, Hahn, giving evidence before a Government Commission, was under cross-examination by another old student, also a barrister, who to-day occupies a seat on the bench. Counsel had refreshed his memory from his old college notes and proceeded to ask Hahn whether marsh gas possessed an odour like that of coal gas. "Mr. Y, you omitted the little word 'not' when you took down these notes," came the instant rejoinder.

Hahn's whole nature was regular and methodical, and this largely contributed to keep him fresh and young in looks until the fatal malady gripped him. Once when travelling from the North he met a student of years before, and the two were in intimate conversation for a lengthy period of the journey, during which a stranger to both entered a compartment. At length the quondam student had to alight; when the train moved on again the stranger, who in silence had been an interested spectator of the parting, turned to Hahn and said: "May I ask, was that your father?" "No, my pupil," was the characteristically terse reply.

Untiring to the last as a worker, he wished, shortly before the end came, and he was too ill to walk, to drive down to the College in order to superintend the preparations for the session which eventually opened on the day after the funeral. He was dissuaded from this, but he succeeded in completing for the Government Scientific and Technical Committee a report which, in view of war conditions, he had been asked to prepare on tartaric acid and the possibility of manufacturing it locally. This report was sent in within a fortnight before his death, and will, it is understood, be published shortly. All who are interested in the new University of Capetown are glad to know that the Prince of Wales has consented to be nominated as its first Chancellor, but few have hitherto been aware that it was at Prof Hahn's suggestion that His Royal Highness had been approached.

One of the most prominent features in Hahn's character was an unswerving insistence that reverence and respect should be paid wherever due. The College once employed as janitor an elderly sergeant named Bassett, who had seen service in the Crimea, and on State occasions wore a double row of military medals. One of the severest verbal castigations ever administered by Hahn—and he could be very severe on occasion—fell to the lot of a student whom he had overheard speaking disrespectfully to the janitor, the student being sternly admonished

never again to treat with anything but the utmost respect one who had gone through so many critical experiences.

Hahn was for years known as the "Father" of the South African College, for the simple reason that he had served longest on the professional staff, but the title also rested on a sounder foundation: apart from his relation to his classes collectively, he made a special point of getting to know all he could about each student as an individual. This characteristic went far to account for the personal attachment of his past students: when any student, past or present, was in difficulty of any kind, either by reason of some misdeed, trifling or serious, or through no fault of his own, Hahn would take him into his sanctum and deal very frankly and paternally with him, and there are men to-day who have admitted that they owe their old Professor more than they could ever repay, and that not so much for the chemistry as the moral lessons which he had imprinted on them during times of crisis.

Prof. Hahn was twice President of the Cape Chemical Society: in 1903 he was President of Section A of the South African Association for the Advancement of Science, and in 1911, at its Bulawayo meeting, President of the whole Association. He was also a member of the British Association for the Advancement of Science, an honorary member of the Chemical, Metallurgical and Mining Society of South Africa, and a member of the South African Association of Analytical Chemists. He likewise held the position of an extra-Academical lecturer of the Universities of Edinburgh, Aberdeen, Glasgow, and St. Andrew's. Several of his former pupils have filled public positions requiring a knowledge of chemistry, and all of these without exception have realised to the full their deep indebtedness to Hahn for the very careful instruction which laid the foundation of many a career of usefulness and of value to South Africa.

C. F. J.

Utilisation of Tomato Waste.—The United States Department of Agriculture has published a Bulletin (No. 632) on the utilization of waste tomato seeds and skins, by F. Rabak, chemical biologist for drug-plant and poisonous-plant investigations. The oil from the seeds should find ready disposal as an edible or soap oil, or, after proper treatment, as a drying oil for paint and varnish purposes. The meal possesses valuable qualities as a stock food, and in view of the shortage of fatty oils, as well as in the interests of food conservation, tomato refuse may be considered as an available source for the manufacture of oil and cake. It was suggested that the utilization of this material should be considered as an economic measure of both agricultural and industrial importance.

GEOGRAPHICAL DISTRIBUTION OF THE SOUTH AFRICAN BRYOPHYTA.

By Thomas Robertson Sim.

Introduction.

Till lately all that was known concerning the South African Bryophyta had been learned from the specimens sent to Europe by a few collectors, each interested in his own locality, except Ecklon, Drege, and Rehmann, who travelled more widely. Ecklon's and Drege's plants were comparatively few in number, and were dealt with long ago, before bryology became an exact science; Rehmann's collections, on the other hand, suffered from the hair-splitting, over-exactitude of Muller during his later years, and also from Rehmann's own inexactitude, the consequence being that we have inherited an enormous number of species founded on single scraps hid away in European herbaria, nearly half of which have been named in these herbaria or in *exsiccatæ*, but have never been published, while of those published the earlier are not easily either confirmed in or excluded from modern classification, while the more recent were described from herbarium specimens or scraps instead of from field experience, and are in far too many cases synonymous, but still remain unadjusted, or they were placed generically when generic characters had not been seen, and required rearrangement later, the final result being an unduly long list of specific names credited to South Africa which has to be worked down by gradual elimination of such as cannot stand as good distinct species.

This has rendered any general review of the South African Bryophyta exceedingly difficult, since in the majority of instances only one or a few localities are recorded for any species, however common, while a rare species, if recognized as such by the collectors, was usually represented from each locality in which it was found. This particularly affects our knowledge of the Transvaal species, since Rehmann, collecting for sale distribution, collected for two years in the Cape Peninsula, Knysna and Natal, before proceeding to the Transvaal, and then collected mostly such species as he had not previously distributed, the result being that his *exsiccatæ* tell us much concerning the rare species of the Transvaal, and almost nothing concerning the common ones.

It has fallen to my lot, after 30 years' residence in and travel through many parts of South Africa, during the whole of which period the Bryophyta have been of constant interest to me, to be now in a position to make certain general observations which may be useful to others.

In doing so, I wish to deal more with locality associations than with individual species, and to leave out of account the enormous number of names having single records, which may or

may not prove distinct, and which may or may not show wide distribution on fuller knowledge.

The number, as also the relative proportion, of endemic species cannot be satisfactorily discussed until the above doubtful factors are cleared up, nor is it advisable meantime to deal in detail with the many forms so closely related to exotics as to be practically the local representatives of these species, but possessed of certain minor characters, present locally and absent elsewhere.

I have, in a previous paper to this Association,* pointed out, in relation to the Hepaticæ, the almost cosmopolitan distribution (under suitable conditions of climate and moisture) of all the larger orders and *genera* of that group, and that it really depends on how wide or narrow a view one takes of what constitutes a species, whether the distribution is world-wide or almost parochial; and as relationship, together with presumably recent and still unstable local variation, exists there in many or most cases, I have, in dealing with the general geographical distribution in the present paper, referred more particularly to the mosses, though the Hepaticæ are also used in the subsequent discussion.

I would, however, repeat here that some tropical *genera* of Hepaticæ have not so far been recorded from South Africa, and that there is a scarcity of certain conduplicate-leaved, cold-region forms (*Scapania, Lophozia,* etc.), which forms may still be found in our mountain streams.

General Geographical Distribution.

The relation of South African Bryophyta to that of other parts of the world takes the following aspects:—

(A) Cosmopolitan Forms, *more or less frequent in suitable localities on each Continent.*—In regard to orders and *genera*, most of the larger groups are represented, except as restricted under (B) and (C). But in regard to identical species, the number is so small that the following list may include most of them:—

Polytrichum commune.
Polytrichum juniperinum.
Ceratodon purpureum.
Grimmia apocarpa.
Tortula muralis.
Weisia viridula.
Funaria hygrometrica.
Mniobryum albicans.
Mnium rostratum.
Bryum argenteum.
Bryum capillare.
Bryum torquescens.
Hedwigia ciliata.
Leptodon Smithii.
Stereodon cupressiformis.
Sphagnum (as a genus).
Dumortiera hirsuta.
Riccia fluitans.
Riccia natans.

* "Hepaticæ." Rept. S.A. Assn. for Adv. of Science, Pretoria (1915), 426-447.

Absent from South America, present elsewhere:—

Grimmia campestris.
Grimmia pulvinata.
Tortula ruralis.
Encalypta ciliata (rare in South Africa).
Encalypta vulgaris (rare in South Africa).

Absent from Australasia, present elsewhere:—

Tortella caespitosa.
Leucobryum glaucum.
Antitrichia curtipendula (rare in South Africa).

(B) NORTHERN TYPE, *extending through Africa to South Africa.*—The relationship of the majority of South African mosses is distinctly of this Northern type, which, with certain local limitations, occupies the whole of the Northern Hemisphere, and extends southward throughout Africa. Thus the relationship of African species with those of Europe, Asia, and North America is greater than that between those of North and South America, or between those of the Northern continents and Australasia.

Of the Northern type all the larger families and orders are represented, some by identical species, most by more or less closely related species. Tetraphidales and Buxbaumiales, Meesiaceæ, and Aulacomniaceæ are absent; Splachnaceæ and Fontinalaceæ are almost absent; *Blinda* is absent, while it is well represented both in the Northern and elsewhere in the Southern Hemispheres; *Dicranum* and *Ulota* are very poorly represented, while Campylopus and Fissidens have very many species each. It would unduly lengthen this paper were I to name the *genera* forming this well-known Northern type, but the following are some of its species which extended South:—

Andreæa rupestris.
Archidium alternifolium.
Pogonatum aloides.
Sælania cæsia.
Octoblepharum albidum.
Coniomitrium julianum.
Grimmia commutata.
Gyroweisia tenuis.
Phascum cuspidatum.
Barbula vinealis.
Orthotrichum affine.
Philonotis fontana.
Bryum alpinium (*B. wilmsii*).
Bryum canariense.
Bryum inclinatum.
Bryum murale.
Rhodobryum roseum.
Pterogonium gracile.
Herpetineuron Toccoæ.
Pleuropus sericeus.
Lindbergia (as a genus).

Although all these except *Lindbergia* occur in Europe, it does not appear that distinctively European species are more prevalent that those more widely distributed in the North; nor is it the case that species belonging to the warmer parts of the Northern Hemisphere have spread southward unaccompanied by others from the colder temperate regions, though these latter often occupy alpine or subalpine positions.

(C) SOUTHERN TYPE.—Intermixed throughout South Africa, and to a considerable extent through Tropical Africa

with the species of the Northern type already mentioned, are a very considerable number of species belonging to *genera* which either entirely or mostly belong to the Southern Hemisphere, and are either absent or poorly represented north of the equator elsewhere than in Africa.

It seems strange indeed, but is the case, that most of these Southern *genera* are represented alike in South America, Australasia, and Africa, indicating that at an earlier period some means of transport or some land connection existed.

Among such *genera* are:—

Psilopilum.	*Gigaspermum.*	*Fabronia.*
Archidium.	*Goniomitrium.*	*Dimerodontium.*
Holomitrium.	*Eustichia.*	*Helicodontium.*
Dicranoloma.	*Bartramidula.*	*Rigodium.*
Leucoloma.	*Glyphocarpus.*	*Hookeriopsis.*
Ptychomitrium.	*Breutelia.*	*Callicostella.*
Hyophila.	*Orthodontium.*	*Cyclodictyon.*
Leptodontium.	*Haplodontium.*	*Squamidium.*
Triquetrella.	*Brachymenium.*	*Calyptothecium.*
Syrrhopodon.	*Rhacocarpus.*	*Porothamnium.*
Schlotheimia.	*Prionodon.*	*Sciaromium.*
Macromitrium.	*Forsstræmia.*	*Catagonium.*

Common to Africa and South America, but absent from Australasia:—

Pilotrichella.	*Porotrichum.*	*Microthamnium.*

Common to Australasia and Africa, but absent from South America, *Trachyphyllum.*

Identical species represented in Africa as well as in other parts of the Southern Hemisphere, but not elsewhere, include:—

Andreæa subulata,
Pleuridium nervosum,
Aongstræmia julacea,
Barbula pilifera,
Rhizogonium spiniforme,
Ditrichum strictum (Hk.f.&W.) Hpe.,
Ditrichum flexifolium (Hk.) Hpe.,

and others.

A very marked deviation from the usual distribution of the Southern type occurs in regard to several Pleurocarpous *genera*, including *Papillaria, Stereophyllum, Floribundaria, Eriopus, Ærobryopsis, Erythrodontium, Hypopterygium,* etc., which inhabit only South America, Africa, and East Asia, crossing the equator in a diagonal line, but not extending to North America, Europe, or Australasia. In this latter connection the most notable absentee from South Africa is the genus *Calymperes*, which is known only from, but is well represented in, South America, Africa, African Islands and East Asia; in Africa it

has many species extending as far south as Madagascar and Angola, but none have yet been reported from South Africa.

(D) AFRICAN SPECIES.—It has already been shown that the African moss flora is composed of a considerable admixture of plants of the distinctively Northern type with plants of the distinctively Southern type, and just as the Northern type has extended southward throughout Africa, so the Southern type has extended northward as far as the Cameroons and Abyssinia.

It is remarkable, however, that Africa, though it has very many endemic species, has very few endemic *genera*, the only ones which occur to me as belonging to South Africa being *Wardia* and *Ischyrodon*, endemic to South Africa, and *Renauldia* and *Coleochætium* common to South and Central Africa.

Although many non-endemic species are widely distributed in Africa, the number of African endemic species known to be common to South Africa and other parts of Africa or its islands is still comparatively small; no doubt this will change considerably as the limitations of the species are better known, and as the Bryophyta of Africa are further studied.

Among such species known meantime are:—

Pogonatum simense.
Polytrichum armatum.
Schistomitrium acutifolium.
Leptodontium epunctatum.
Macromitrium Dregei,
Cryphæa exigua.
Erpodium grossirete.
Erpodium Hanningtoni.
Renauldia Hoehnelii.
Brachymenium pulchrum.
Prionodon Rehmanni.
Rauia abbreviata,
Porothamnium pennæforme.
Ectropothecium regulare.
Vesicularia sphaerocarpa.
Neckera Valentiniana,
Hypopterygium laricinum.
Rhacopilum capense.
Rhodobryum umbraculum.

(E) SOUTH AFRICAN SPECIES.—Although what constitutes a *genus* is always open to debate, the only two *genera* I think of meantime as endemic to South Africa are *Ischyrodon* and *Wardia*. *Ischyrodon* is closely related to *Fabronia* and to other South African members of *Fabroniaceæ*; but *Wardia hygrometrica* Harv. is one of the remarkable puzzles in geographical botany. It occurs only on and in the neighbourhood of Table Mountain, where it is abundant on rocks in running streams, and belongs to the aquatic family *Fontinalaceæ*, which is well represented in many parts of the Northern Hemisphere, extending as far south as Algeria and Abyssinia, but, except *Wardia*, the only member of the family known from the Southern Hemisphere is one very different plant from Venezuela. When and how these two plants originated is even more difficult to conjecture than is the history of most others.

Of South African *endemic* species, as meantime accepted (in comparative ignorance of many of them), the list is enormous, but there can be no doubt but that many will eventually be sunk as synonyms, or merged as forms or varieties into more widely distributed species. This process is going on slowly.

and must continue to do so, partly through the difficulty of getting at the original types, partly through the small number of bryologists who know South African species and also exotic species sufficiently well to determine the limitations of each species. Meantime additional species are being discovered, some new, others already known elsewhere.

The greatest difficulties in regard to distinctively South African species are that hundreds of them have been named and distributed without descriptions having been published; that many have been named in private herbaria or in letters without having been either published or distributed; and that in his later years C. Muller described as new many which were identical with earlier published species. These difficulties I am trying to remove in my "Handbook of the Bryophyta of South Africa," now in course of production. Of the 171 *genera* of mosses therein described, into which are distributed the 875 mosses enumerated in my Check List (1915) as having been (rightly or wrongly) credited to South Africa, and included meantime as a basis for further study, nine *genera* are regarded as doubtfully South African, viz.:—

Polytrichadelphus,	*Paludella,*
Brachydontuim,	*Leptostomum,*
Drummondia,	*Cyathophorum,*
Splachnum,	*Acrocladium.*
Amblyodon,	

16 *genera* have no known South African endemic species, viz.:—

Andreæa,	*Venobryum,*
Distichium,	*Antitrichia,*
Rhabdoweisia,	*Homalothecium,*
Schistomitrium,	*Pleuropus,*
Octoblepharum,	*Anomodon,*
Aloina,	*Herpetineuron,*
Gyroweisia,	*Floribundaria,*
Encalypta,	*Trachyphyllum,*

while the remaining 146 *genera* have species claimed to be endemic to South Africa, many of these *genera* being represented in South Africa *only* by such endemic species, while others have also species known from elsewhere.

Among the larger *genera* which each have many endemic species are:—

Sphagnum,	*Hymenostomum*	*Brachymenium,*
Campylopus,	*Syrrhopodon,*	*Webera,*
Fissidens,	*Orthotrichum,*	*Bryum,*
Grimmia,	*Macromitrium*	*Fabronia,*
Tortula,	*Schlotheimia,*	*Rhynchostegium,*
Barbula,	*Entosthodon,*	*Rhynchostegiella,*
Tortella,	*Bartramia,*	*Plagiothecium,*
Trichostomum,	*Glyphocarpus*	*Rhaphidostegium.*
	Philonotis.	

thus showing that both the Northern type and the Southern type have suffered considerable modification through residence in South Africa. But many of these so-called endemic species are so closely related to one another and to exotic species as to suggest that they are the South African representatives of these exotics, either habitually or occasionally subject to modification by local surroundings, and that numerous specimens and fuller knowledge in growth may demonstrate that many are either synonyms, varieties or forms, and that the distribution of the species into which they are included is thereby greater than is at present known. Also, it is abundantly evident that much has yet to be learned regarding the local distribution of every species.

(F) EXOTIC INVADERS.—It seems probable that at least two species are recent arrivals, imported along with garden plants, viz., *Leptobryum pyriforme* (L), which occurs in several places in greenhouses or gardens, and propagates rapidly apart from sexual reproduction by rhizomatous tubers, and *Lunularia cruciata,* which also occurs in similar localities, always barren, but propagates freely by gemmæ. Both these are known as invaders in various other countries; both may be transported for weeks as practically invisible resting-buds (tubers and gemmæ); and though both have been collected once or twice apparently wild in Africa, the doubt as to their being indigenous is hardly dispelled. There may be other naturalized exotics, but I am not aware of them.

SOUTH AFRICAN DISTRIBUTION.

I. The regional distribution of the Bryophyta throughout South Africa does not correspond quite with that of the higher plants, as usually described; at least, there is not yet sufficient evidence that such is the case. But, for the Bryophyta, certain geographical regions may be outlined as follows:—

DISTRIBUTION GENERAL IN SUITABLE LOCALITIES.—This includes some of all types from xerophytes to hydrophytes, and from each class of situation, and many of the cosmopolitan species already mentioned, as well as other common mosses, among which may be mentioned:—

A. In forest conditions:—

Leptodon,	*Brathythecium,*	*Metzgeria,*
Neckera,	*Rhaphidostegium,*	*Aneura,*
Entodon,	*Hypopterygium,*	*Radula,*
Thuidium,	*Macromitrium,*	*Plagiochila,*
Stereodon,	*Rhodobryum,*	*Frullania,*
Porothamnium,	*Leucoloma,*	*Madotheca,*
Pilotrichella,	*Mnium,*	*Ptycholejeunea,*
Papillaria,	*Atrichum,*	*Eu-lejeunea.*
Pseudoleskea,	*Dumortiera,*	

B. In other than forest conditions:—

Polytrichum,	*Tortula,*	*Riccia,*
Pogonatum,	*Funaria,*	*Blyttia,*
Trematodon,	*Bryum,*	*Kantia,*
Ditrichum,	*Ptychomitrium,*	*Cephalozia,*
Campylopus,	*Physcomitrium,*	*Fossombronia,*
Fissidens,	*Bartramidula,*	*Fimbriaria,*
Weisia,	*Fabronia,*	*Marchantia,*
Philonotis,		

and from wet situations *Sphagnum* and *Anthoceros.*

II. South-Western Region.—This region, as is well known, differs in respect of climate (it has winter rains and dry summers), from the rest of South Africa. The higher plants characteristic of it are of a distinct schlerophyllous type, including a large number of ericoid and other species which occur in this region and nowhere else. It is interesting, therefore, to find that in addition to other Bryophyta this region has a fair number of species common in it, but not known from elsewhere, among which may be mentioned:—

Wardia hygrometrica,	*Rhacocarpus,* several sps.
Fissidens plumosus,	*Dicranoloma,*
Fissidens linealis,	*Lindigina,*
Dicranum tabulare,	*Jamesoniella colorata,*
Rhacomitrium incanum,	*Rhizogonium vallis-gratiæ,*
Ischyrodon, 2 sps.,	*Marchatina tabularis,*
Coleochætium, 2 sps.	*Schistochila alata.*

These intermingle freely with the more generally distributed species.

III. Eastern Region.—This region extends from Knysna to Zululand, and from the ridge of the central escarpment on the Drakensberg to the Indian Ocean, and has a rainfall of 20 to 30 inches per annum in most places, but up to 100 inches in some forest and mountain localities.

It includes most of the forests of South Africa, as also most of the mountains, and is favoured in most localities with more humid conditions than other parts of South Africa; consequently in it the Bryophyta, and especially the epiphytic forest types are well represented.

The variations of humidity, altitude, aspect, shade, vegetation and surface are, however, very marked and very rapid; from these causes a total change in the type of moss-vegetation often occurs within a few yards, and each side retains its character as long as conditions remain unaltered, usually in accordance with the higher vegetation of the locality.

In this region the bryophytic species of each of the other regions intermingle, except such species as are peculiar to each of these; it has consequently a very large number of such widely distributed species, in addition to what are peculiar to itself.

Many species only once collected have not yet been found elsewhere, but that is probably not always due to absence else-

where; there are, however, fewer common species which are absent elsewhere than is the case in the other regions; in other words, its special conditions are less marked, and reflect themselves less in the flora than is the case in these other regions.

Among common forms may be mentioned:—

A. In forest conditions:

Rhacopilum.
Rhaphidostegium.
Microthamnium.
Thuidium.
Pseudoleskea.
Pleuropus.
Papillaria.
Ptycholejeunea.

Floribundaria.
Hypopterygium.
Entodon.
Neckera.
Aerobryopsis.
Pilotrichella.
Campylopus.
Madotheca.

Breutelia.
Macromitrium.
Schlotheimia.
Fissidens.
Rhizogonium spiniforme.
Dumortiera.
Plagiochila.
Radula.

B. In other than forest conditions:

Trematodon.
Leucoloma.
Ditrichum.
Campylopus.
Fissidens.
Hymenostomum.
Weisia.
Hyophila.

Ptychomitrium.
Physcomitrium.
Funaria.
Brachymenium.
Bryum.
Polytrichum.
Fabronia.
Thuidium (small sps.).

Marchantia Wilmsii
Fimbriaria.
Plagiochasma.
Riccia.
Frullania.
Nardia.
Anthoceros.

In this as well as in the South-Western region certain species or forms are said to be more or less constantly maritime, but the elasticity of these is not fully known yet, and such a name as *Hedwigidium maritimum* (C.M.) Par. is rather a misnomer for a moss found near Lydenburg, a hundred miles or more inland.

IV. Western and Central Region.—This extends from the main watershed on the Drakensberg to the Atlantic, embracing the Orange Free State, the Karroo, Namaqualand, and Bechuanaland, all more or less flat and arid, devoid of forest, and with rainfall usually less than 20 inches per annum—in some parts less than an average of five inches per annum.

The West African Protectorate and the Western Transvaal mostly belong here also. The species found in this region are peculiarly xerophytic, and able to endure in some condition long periods of extreme drought, even though more or less hygrophytic, where opportunity occurs elsewhere.

Of *genera* peculiar to this class of locality may be mentioned:—

Gigaspermum. ... *Targionia.*
Goniomitrium. ... *Grimaldia.*

and others which occur include:—

Didymodon afer.
Entosthodon Bergianus.
Weisia, sps.
Hymenostomum, sps.
Physcomitrium, sps.
Tortula muralis.
Tortula pilifera.
Fissidens, several small sps.
Bryum, several sps.
Ptychomitrium crispatum.
Ptychomitrium cucullatifolium.
Pseudoleskea claviramea.
Grimmia Ecklonii.
Fabronia pilifera.
Stereodon cupressiformis.
Campylopus nano-tenax.
Riccia, several sps.
Plagiochasma.
Fimbriaria.
Fossombronia.
Cephalozia.
Lophocolea.

Forests are absent, Sphagnum is absent, few pleurocarpous mosses are present, few foliose Hepaticæ are present, trees are scarce, and consequently epiphytes are few, and the usual habitats of the Bryophyta in this region are either where moisture and shade are obtainable under cover of rocks, or on the banks rising from water-pools. The conditions prevailing are not favourable, consequently the few species present are peculiar and interesting.

V. Northern Region.—This region includes the Eastern and Northern Transvaal, the Portuguese East African Province, Swaziland and South Rhodesia, almost all tropical, and all draining into the Indian Ocean north of Natal.

Coastward it is composed of xerophilous leguminous open forest, very poor in Bryophyta; westward it includes the high dry prairies of Rhodesia, poor in Bryophyta, except in the few wooded valleys, but between the coast belt and the prairies there extend the mountain ranges separating the Transvaal and Rhodesia from Portuguese East Africa, forest-clad on their eastern slopes, which are still unexplored for Bryophyta; but as they are known to contain many ferns, they may be assumed to contain many mosses and liverworts also.

From Barberton and Pretoria northward, including the Woodbush, species occur which have not been found further south, but which have relations northward. Among these are:

Leptodontium.
Rhachithecium.
Trachyphyllum.
Levierella.
Lindbergia.
Barbula, several species.
Funaria, several species.
Webera, several species.
Erpodium, several species.
Stereophyllum, several species.
Erythrodontium.
Rauia.
Rigodium.
Herberta.

Among the most common mosses in the forests, as also in the open country, are those common in the Eastern region; one of the marked features, however, is that *Rhacopilum*, which, in the Eastern region is usually a sub-epiphytal forest species, and often fertile, is here present in many open streams as wide mats on stones frequently submerged, and is seldom fertile.

Sphagnum is present in open swamps, though rare; epiphytes are abundant in the forests and forest-clumps; mesophytes like *Atrichum androgynum*, *Microthamnium pseudoreptans*, *Thuidium promontorii*, *Rhodobryum roseum*, and *R. umbraculum* are common where there is forest shade, and *Macromitrium* sps. and *Brachymenium pulchrum* are abundant on trees apart from the forest. But in this region, more than in any of the others, much has still to be added to our knowledge of the Bryophyta, and collectors should note that specimens are desired.

VI. Mountain Regions.—On the tops of the mountains at elevations of 5,000 to 10,000 feet in Natal, Basutoland, and Orange Free State, and at gradually reduced altitudes southward to about 3,000 feet at Table Mountain, species which are of a distinctly alpine type occur freely, and usually either correspond with or are closely related to alpine species of other countries. Owing to the rigorous nature of the habitat these species are often more or less in complete possession, forming wide, flat mats on nearly bare rock, and a large proportion of them have hair-pointed leaves, hyaline in many cases. Fructification is rare or usually absent in many of these species; still, in their own habitat these are well represented, asexual reproduction by detached buds or branches taking place in several and possibly in most cases.

Among these alpine forms are:—

Campylopus.	*Bryum alpinum* (*Wilmsii*).	*Chæondanthus hirtellus.*
Rhacomitrium.	*Bryum syntrichioides.*	*Aongstræmia.*
Grimmia.	*Bryum afro-alpinum.*	*Polytrichum.*
Andreæa.	*Bryum oranicum.*	*Pogonatum.*
Gymnostomum.	*Bryum argenteum.*	*Psilopilum.*
Zygodon.	*Sælania cæsia.*	*Corsinia.*
Breutelia.	*Ditrichum.*	*Fimbriaria.*
Hedwigia.		*Anthoceros.*

And in wet places or along streams occur:—

Sphagnum.	*Bryum.*	*Fissidens.*
Philonotis.	*Hygroamblystegium.*	*Conomitrium.*
Bartramidula.	*Drepanocladus.*	*Blyttia.*
Trematodon.	*Amblystegium riparium.*	*Marchantia.*
Eustichia.	*Leucobryum.*	*Symphogyna.*
Mnium.		*Riccia fluitans*, etc.

And on Table Mountain *Schistochila alata* (the only South African representative of the large Northern family Scapiniaceæ), and *Jamesoniella colorata*.

Systematic Distribution.

It may be of interest briefly to state the South African representation of the orders into which the Bryophyta of the world are arranged, as some are entirely absent. These absences are

not difficult to explain, the climatic conditions being unfavourable.

The latest and apparently the most satisfactory classification is that given in Cavers' "Inter-relationship of the Bryophyta" (1911), following which we find the representation to be:—

I. SPHÆROCARPALES.—Represented only by one species of *Riella,* only once seen.
II. MARCHANTIALES.—Well represented, but Monocleaceæ and Cleveaceæ are absent.
III. JUNGERMANNIALES.—Well represented, the most notable feature being that the large family Scapaniaceæ is represented by one species only, and that confined to the S.W. region, so far as is known.
IV. ANTHOCEROTALES.—Well represented by *Anthoceros. Dendroceros* has not yet been found, though known from Africa and its islands, South America, and Australasia. *Notothylas* and *Megaceros* are absent.
V. SPHAGNALES.—Present but rare in the moister and fully exposed localities; most frequent on Table Mountain; absent from the Karroo and from all forests.
VI. ANDREÆALES.—Represented by one or two species, very rare; found only on mountain rocks.
VII. TETRAPHIDALES.—Absent from Africa; known only from the Northern Hemisphere, New Zealand, and Samoa.
VIII. POLYTRICHALES.—Well represented, and through the laminated leaves well suited for exposed but showery localities.
IX. BUXBAUMIALES.—Absent from Africa except Madeira); known only from Northern Hemisphere and East Indies, and one species in each of New Guinea, Tasmania, Peru, South-Eastern Brazil, and Viti Island.
X. EU-BRYALES.—Well represented by most of the temperate and sub-tropical families. Some absentees have already been referred to. Permanent marshes being almost absent, swamp mosses are few, and through unsuitable climatic conditions Splachnaceaæ is almost absent.

ECOLOGY OF SOUTH AFRICAN BRYOPHYTA.

From the ecological standpoint there is present much of great interest in the South African Bryophyta. The following types occur:—

I. PIONEER SPECIES COLONIZING NEW GROUND.—Almost all the Bryophyta may be pioneers, but in different degrees, some species, and especially under certain conditions, being the earliest colonizing species of plants, while others may sometimes be so, but probably more often follow blue-green Algæ and Lichens. Intimately connected with the behaviour of each species in this respect is the nature of the *nidus* required by its spores in order to germinate and to develop into plants; in some (as in Funaria)

the sterilized surface left by a forest fire suits for immediate germination and maintenance; in others (*Fissidens Wageri*, *etc.*), newly cut, moist, earth-banks meet the requirement. In the larger number of cases Algæ are present first, and probably regulate the constant presence of a necessary moisture-film to induce germination and to maintain early life; lithophytes probably require lichens, even to keep the Algæ from being dried off; while in the case of all hydrophytes the constant presence of water in some quantity is essential. In each case the presence of Bryophyta eventually forms a humus, in which, if surrounding conditions allow it to accummulate, higher plants may be able to live where formerly they could not do so.

Conditions and sites suitable for pioneers include:—

A. Disturbed Ground, such as ditch and river banks, railway and road cuttings, cultivated land, dry stream beds, etc.:—

1. *In shade*, either of overhanging trees or of the banks themselves.

These include:

Fissidens (minute species).	*Trematodon.*
Entosthodon.	*Polytrichum.*
Haplodontium.	*Brachythecium.*
Ditrichum.	Etc.

2. *In similar localities, but extending also into full exposure*, so long as the soil continues more or less moist, as it usually does in vertical cuttings, or sloping banks:

Pogonatum.	*Funaria.*	*Fossombronia.*
Polytrichum.	*Archidium.*	*Notoscyphus.*
Anomobryum.	*Pleuridium.*	*Cephalozia.*
Bryum.	*Riccia.*	*Kantia.*
Phascum.	*Blyttia.*	Etc.

3. *On flat open land*:

Phascum.	*Hymenostomum.*	*Bryum.*
Entosthodon.	*Weisa.*	*Brachythecium.*
Fissidens.	*Campylopus* (small sps.).	*Riccia.*
Ditrichum.	*Pleuridium.*	*Kantia.*

B. After Forest of Wattle Plantation Fires.—The huge forest fires which occasionally occur, and the plantation fires which form a necessary process in wattle culture, are quickly and almost invariably followed by a dense growth of *Funaria hygrometrica.* Species of *Entosthodon* and *Ditrichum* appear later on the soil; *Rhaphidostegium* appears on the tree-stumps as soon as they begin to decay; *Rhodobryum*, *Atrichum*, *Pogonatum*, *Campylopus*, *Bryum*, and *Fossombronia* come soon if the soil is moist, while if the soil is dry only *Campylopus* and *Rhaphidostegium* become established before forest regrowth alters the conditions again.

C. ON MOUNTAIN SUMMITS AND DENUDED ROCKS ELSEWHERE.

Rhacomitrium,	*Zygodon.*	*Grimmia,*
Campylopus,	*Polytrichum.*	*Bryum argenteum.*
Andreæa,	*Pogonatum.*	*Hedwigidium.*

and other *genera* already mentioned as belonging to the Mountain Regions, and which will be referred to again later.

But apart from the mountains, and sometimes even near the sea (as at Murchison Flats, Natal), flat, bare rocks become gradually encroached upon by masses of:—

Hymenostomum.	*Tortula.*	*Kantia.*
Weisia.	*Brachythecium.*	*Riccia.*
Campylopus (dwarf sps.).	*Pseudoleskea.*	*Blytha.*
	Cephalozia.	*Fimbriaria.*
Bryum argenteum.		Etc.

D. IN AND NEAR FLOWING STREAMS.—Usually as chomophytes anchored in cracks of the rock, though often extending outward as saturated lithophytes.

1. *On the Drakensberg and other high mountains:*

Philonotis.	*Amblystegium.*	*Sœlania.*
Bartramidula.	*Hygroamblystegium.*	*Blyttia.*
Breutalia.	*Drepanocladus.*	*Fimbriaria.*
Bryum.	*Fissidens.*	*Aneura.*
Eustichia.	*Gymnostomum.*	*Anthocerus.*
		Etc.

2. *On Table Mountain* the following and other *genera* occur:

Wardia.	*Rhacomitrium.*	*Schistochila.*
Rhacocarpus.	*Leucoloma.*	*Marchantia.*
Dicranum,	*Campylopus.*	*Aneura.*
Dicranoloma,	*Fissidens.*	Etc.,

and have species endemic to that locality in this class of situation, and *Sphagnum* and *Chanondanthus* are more frequent there than elsewhere, on moist or wet rocks.

3. *In streams which are not mountain streams, exposed:*

Fissidens.	*Bryum.*	*Trematodon.*
Conomitrium.	*Philonotis.*	*Symphogyna.*
Hyophila.	*Entosthodon.*	*Riccia fluitans.*
Hymenostomum.	*Rhacopilum.*	*Fossombronia.*
		Etc.

4. *In shaded forest streams:*

Fissidens.	*Microthamnium.*	*Mnium.*
Hyophila.	*Floribundaria.*	*Aneura.*
Entodon.	*Porothamnium.*	*Dumortiera.*
Thuidium.	*Stereodon.*	*Marchantia.*
		Etc.

5. *Submerged, either regularly or frequently:*

Fissidens.	*Bryum.*	*Aneura.*
Conomitrium.	*Amblystegium.*	*Dumortiera.*
Hyophila.	*Wardia.*	*Marchantia.*
Mnium.	*Riella.*	*Fossombronia.*
		Etc.

E. As Epiphytes on Tree Stems.—Although a very large proportion of the Bryophyta frequently occur as epiphytes on tree stems, many of these are rather *succession plants* following up and taking advantage of the pioneer work done by a small number of species. Among the pioneers are:—

Macromitrium.	*Brachymenium.*	*Frullania.*
Fabronia.	*Tortula.*	*Madotheca.*
Rhaphidostegium.	*Barbula.*	*Radula.*
Orthotrichum.	*Rhacopilum.*	*Plagiochila.*

Other epiphytes succeeding or accompanying these will be mentioned under the Climax Types.

F. On Walls, Stones, Cement Work, Etc.—This is the favourite haunt of these *genera*:

Tortula.	*Bryum.*	*Stereodon.*
Tortella.	*Brachymenium.*	*Rhynchostegium.*
Barbula.	*Bartramia.*	*Brachythecium.*
Weisia.	*Macromitrium.*	Etc.

Many other *genera* appear after humus has been formed by these, if the walls remain moderately damp. If very dry no Bryophyta appear.

II. Climax Types.—While almost all the Bryophyta may be pioneers on occasion some are also able to establish themselves as relatively permanent inhabitants, and thus remain as long as favourable conditions continue. Notable among these are:

1. Xerophytic Associations.—These are fit to endure permanently the arid conditions of the Western and Midland Region, or of the fully exposed localities in the Eastern Region, and in the Northern Region. These conditions seldom become moister, and often become drier; still, the species forming these associations survive, or continue to appear.

These associations include all the species already mentioned as belonging to the Western and Midland Region, and in the Eastern and Northern Regions it includes species of:

Weisia.	*Fissidens.*	*Riccia.*
Hymenostomum.	*Ptychomitrium.*	*Fimbriaria.*
Trichostomum.	*Brachythecium.*	*Kantia.*
Campylopus.	*Rhynchostegium.*	

2. Mesophytic Associations.—Between the xerophytic type and the hygrophilous type comes the mesophytic type,

unable to endure extreme drought, and still seldom connected with quite wet conditions. The plants composing this type live on the soil, or on humus, and prefer it to be usually moist, but never continuously wet. Through the seasonal extremes to which South Africa is subject the proper conditions for this type usually exist as forest carpet rather than under full exposure to sunshine, although there are species of *Polytrichum*, *Pogonatum*, *Ditrichum*, *Fissidens*, *Bryum*, *Anomobryum*, *Brachythecium*, *Trematodon*, etc., which prefer sunshine.

Among the forest *genera* of this type may be mentioned:

Atrichum.	*Bryum.*	*Sterodon.*
Rhodobryum.	*Mnium.*	*Thuidium.*
Fissidens.	*Campylopus.*	*Entodon.*
Dicranella.	*Rhaphidostegium.*	*Hedwigia.*
Funaria.	*Pseudoleskea.*	*Kantia.*
Leucoloma.	*Microthamnium.*	*Plagiochila.*

It is frequently the case that species of these *genera* occur separately, forming monotypic associations, but it is also the case that miscellaneous mixtures occur, containing many species. In this association the permanency of the grouping depends mostly upon continuous regularity of the forest cover; if it become either more dense or more open the balance is upset, and some species gradually give place to others.

Hygrophilous Associations.—The most marked but the least common hygrophilous association in South Africa is that composed of *Sphagnum*, which usually occupies a saturated position on rock, or on mud overlying rock, where the rock itself prevents the escape, except by overflow, of a slowly meandering stream fully exposed to sunshine. This is often a monotypic association, though *Bartramidula*, *Philonotis*, *Bryum*, *Campylopus*, *Blyttia*, *Symphogyna*, *Notoscyphus*, and various grasses or similar plants, occasionally become part of it, and as it raises itself into drier conditions *Anthoceros*, *Leucobryum*, *Mnium*, etc., come in, followed later by certain phanerogams.

Climatic and physical conditions seldom favour in South Africa the formation of extensive *Sphagnum* moors or bogs like those of Europe, consequently *Sphagnum* is rare, and Meesiaceæ and Aulacomniaceæ probably absent.

Riccia fluitans and *R. natans* are both amphibious, and have forms which float in slow pools, unattached to the soil, as well as different land forms.

But hygrophilous associations are connected with every stream, and some of the species already mentioned as pioneers under varying conditions become the climax type in a stream as long as the conditions remain unaltered.

A submerged bed of *Aneura*, *Dumortiera*, *Wardia*, *Conomitrium* or *Hyophila* may last for a very long period without effecting any further colonization, and saturated cushions of *Philonotis*, *Fissidens*, *Hygroamblystegium*, *Campylopus*, *Bryum*, *Marchantia*, etc., frequently remain almost submerged for many years, their only apparent object being to expose a saturated

surface to the atmosphere instead of a dry rock. *Rhacopilum* does so in the Eastern Transvaal streams, and many other species are more or less constantly associated with water.

4. EPIPHYTIC ASSOCIATIONS.—These occur either on bark or on stones, or on both; sometimes even on tree leaves or upon other mosses under forest or swamp conditions. The pioneer species usually start on the slime of Algæ or lichens, but often arrive at a condition of permanent occupation which lasts as long as the suitable condition lasts, and then when the forest is opened out and forest regrowth begins, these species again resume pioneer service on the regrowth.

But in addition to the naturally pioneer species (some of which have already been mentioned), many other succession species appear after a time, sometimes as true epiphytes, more frequently as mesophytes living on the humus formed by the decay of earlier generations. Some are even so independent of attachment that they continue to live and flourish if detached from their anchorage, and hang upon branches in moist forest; some, again, are so nearly parasitic that it is only upon living wood that they continue to grow, while others live easily as epiphytes either on living or dead wood, or on stones, or humus, sometimes extending even on to soil.

During the whole of the permanent occupation by these Bryophyta they are of immense advantage in the economy of nature in the direction of forming humus and of acting as a surface sponge into which available moisture is accepted and retained until wanted by changed hygrometric conditions, and even in those which hang loosely, and consequently form no sponge, the ability to absorb and retain moisture under imbricated leaves or in other similar situations has much to do with the permanently cool and moist condition usually prevalent inside a forest. It must not be lost sight of, however, that these epiphytes have often to undergo periods of intense drought, and that they must possess water-retaining arrangements capable of collecting and enduring moisture to an unusual degree.

Examples of the types mentioned include:—

A. Usually pioneers; afterwards climax type:—

1. *Leaf parasites* (*i.e.*, living on living leaves):—*Microlejeunea*, *Radula*, *Frullania*.
2. *Bark parasites* (*i.e.*, living on living bark, and often as isolated plants or patches on bark fully exposed to sunshine, and frequently high up the trees, or on trees away altogether from forest conditions.

Fabronia, *Orthotrichum*, *Frullania*,
Macromitruim sps. *Radula*, etc.

3. EPIPHYTES ON LIVING BRYOPHYTA:—

Eu-lejeunea,	*Fimbriaria*,
Metzgeria,	*Kantia*,
Radula,	*Cephalozia*,
Frullania Ecklonii,	*Lepidozia*, etc.

4. Epiphytes on Living or Dead Wood, or on Humus or Stones:—

Brachymenuim pulchrum	*Tortula.*
Macromitrium.	*Barbula.*
Pseudoleskea.	*Madotheca.*
Rhaphidosteguim.	*Frullania*, etc.

B. Usually Succession Species, forming climax type, while conditions remain unaltered:—

5. On Tree Stems, whether living or dead, or on Humus connected with Stumps:—

Campylopus.	*Dasymitrium.*	*Thuidium.*
Leucoloma.	*Hedwigia.*	*Pleuropus.*
Bartramia.	*Cryphæa.*	*Rhaphidostegium.*
Tortula.	*Forsstroemia.*	*Ptycholejeunea.*
Barbula.	*Renauldia.*	*Madotheca.*
Rhizogonium.	*Stereodon.*	*Frullania.*
Mnium.	*Porotrichum.*	*Eu-lejeunea.*
Bryum,	*Neckera,*	*Metzgeria.*
Schlotheimia.	*Prionodon.*	*Plagiochila.* etc.
Leucobryum.	*Radula.*	

6. On Tree Stems or on Stones, or hanging as detached Air-plants:—

Pilotrichella,	*Papillaria*	*Metzgeria,*
Acrobryopsis,	*Brachymenuim*, etc.	*Macromitrium.*

7. Usually on Stones or accumulated Humus:—

Fissidens.	*Hypopterygium.*	*Cyclodictyon,*
Leptodon.	*Ptychomitrium.*	*Hookeriopsis,*
Entodon,	*Trichostomum.*	*Pseudoleskea,*
Rhacopilum.	*Microthamnium.*	*Dimerodontuim.*
Thuidium,	*Ectropothecium.*	*Hedwigidium, etc.*
Porothamnium.	*Vesicularia.*	
Floribundaria.	*Hookeria.*	

5. Alpine Associations.—While most of the Alpine species are pioneers in the establishment of plant communities on practically bare rock, the exigencies of climate (including a daily thunderstorm during certain months, nightly mists or dews almost throughout the year, great intensity of light, extreme rarification of the atmosphere which brings about complete dessication within a few hours, and severe wind and winter conditions) almost preclude the possibility of a permanent phanerogamic flora, and though *Selaginella rupestris* and several small bulbs usually join the association, it must take a very long time indeed to establish even a grass-veld on a solid trap or a burned sandstone rock; consequently it often happens that the pioneer Bryophyta have come to stay, and eventually form the final stage in plant-succession for that locality, as matted lithophytes. All the Bryophyta already mentioned as belonging to the Mountain Regions share in this tendency, though

some are considerably restricted by their water requirement. Genera which permanently inhabit the drier rock surfaces include:—

Andreæa,	*Campylopus,*	*Polytrichum,*
Rhacomitrium,	*Bryum (argenteum),*	*Ptychomitrium,*
Grimmia,	*Zygodon,*	

while somewhat moister rock margins have also:—

Bartramidula,	*Aongstræmia,*	*Bryum alpinum,*
Pogonatum,	*Sælania,*	*Bryum afro-alpinum,*
Ditrichum,	*Trematodon,*	etc.

a truly wonderful mixture sometimes being found on our frequently snow-clad mountain summits of species separately representing the highest mountain types of Europe, Asia, North America, South America, New Zealand, Tristan d'Acunha, Abyssinia, and Central Africa, all healthy and vigorous on these respective mountain summits, though absent or almost absent elsewhere.

General Conclusions.

What has been said leads us to these general conclusions:—

South Africa is rich in species of Bryophyta, many endemic; but poor in endemic *genera*.

South Africa appears to be the common meeting-ground of Northern types, Southern types, and another diagonal type, in addition to whatever may belong to Africa and its islands, or be endemic to South Africa.

This common meeting-ground is very pronounced, and very remarkable among the comparatively few species inhabiting the mountain summits.

These facts indicate probable former land connections where no such connections have existed for a very long time past, that long period accounting for specific variation after the generic characters of the mosses and the main divisions of the Hepaticæ had become fairly well fixed.

The aggression of climatic conditions, regulated by the huge more or less arid area, over the smaller and retrogressive humid areas, accounts for the wide distribution in suitable but now separated spots, of many cosmopolitan and other species, which are unable to survive in the arid or semi-arid intervening and adjoining tracts. The Eastern Region, consequently, has a rich and varied bryophytic flora.

On account of aridity Bryophyta are few, scarce and peculiar west of the main escarpment.

Tropical conditions bring tropical species as far south as these conditions extend.

The South-West region is more specialized than the others, as also is the case in regard to its higher flora, indicat-

ing the presence of some relationship distinct from that of the other regions, or else an extraordinary environment influence.

The distribution of the systematic orders is quite in accordance with the climatic conditions.

South Africa having been subjected continuously through ages to erosion, the Bryophyta perform very important pioneer duty in connection with the reclothing of new surfaces, leading up to higher vegetation where that is practicable, or forming the ultimate stage of plant-succession where severe conditions so direct.

In the ultimate stage of plant-succession elsewhere (*i.e.*, where forest exists), the Bryophyta are a most important factor in retaining humidity, and thereby preventing forest retrogression from going on more rapidly.

Spores are locally air-carried and ubiquitous; as soon as favourable conditions present themselves they germinate, but it is very remarkable how every species is absent from all except its own *habitat*, probably through absence of these "favourable conditions" at some early stage, under circumstances of which we are still totally ignorant.

After huge forest fires and after artificial interference with the soil surface Bryophyta rapidly prepare the way for the next stable vegetation.

The influence of the chemical contents and physical condition of the soil or rock formation on distribution of Bryophyta has not been noted sufficiently to lead to any classification or general remarks in that respect.

(*Read, July* 4, 1917).

Ostrich Leather.—A tanned ostrich skin sent to the Union Trades Commissioner in London some time ago was submitted by him to one of the most expert fancy leather tanners in the United Kingdom. The latter reported that, in his opinion, the most likely purpose that such leather could serve would be for dressing-case work or travelling bags. A suitable shade of green was suggested as a colour, or else some of the art shades or saddle brown. Another possible use was for furniture covering.

Water Vapour in the Sun.—Prof. A. Fowler, F.R.S., of the Imperial College of Science and Technology, in a paper recently read by him before the Royal Society, showed that the band λ 3064, usually attributed to water vapour, is quite strongly represented in the solar spectrum, and accounts for at least 150 lines previously unidentified.

THE VOLATILE ACIDITY OF WINE: PARTICULARLY THAT PRODUCED BY PURE CULTURES OF YEAST.

By Prof. Abraham Izak Perold, B.A., Ph.D.

Introduction.

Whilst I do not for a moment deny that the bulk of the volatile acids found in wines containing a high volatile acidity must be ascribed to the action of bacteria, I hope to show in the course of this paper that appreciable, and even very considerable, amounts of volatile acids are and can be formed by pure cultures of yeast. I shall first give a brief review of such literature on this subject as was accessible to me, after which I shall give a *résumé* of some investigations on this subject made in the Œnological Institute at Elsenburg. My assistant, Mr. François Février, B.A., carried out the practical part of these investigations under my supervision, for which I wish here to tender him my heartiest thanks. These investigations were undertaken partly on account of their purely scientific interest, and partly on account of the light they might shed on the question of the volatile acidity in our wines looked at from a commercial standpoint I shall revert to this aspect of my subject at a later stage.

Historical Review.

Pasteur (**1**)* and Béchamp (**2**) first showed that acetic acid is formed during the alcoholic fermentation of grape-juice or must when working with pure cultures of elliptic (wine) yeast. Duclaux (**4**), in comparing this formation of acetic acid with that of alcohol during the same fermentation, points out that, whilst they both have the sugar as their source, the sugar need merely enter the yeast cell to meet the zymase which decomposes it into alcohol and carbon dioxide, whereas the volatile acids are the products of secretion or excretion of protoplasmic activity. He continues: "Ils sont le produit d'une action vitale, auméme titre que l'alcool est le produit d'une action diastasique." He showed that, even when no sugar is present, yeast left by itself will slowly produce some volatile acid at the expense of its cell contents. He further showed that more volatile acid is formed in the presence of large numbers of yeast cells after the sugar has been fermented out than before this happens. He also states that more volatile acid is formed under conditions that are unfavourable.

Büchner and Meisenheimer (**5**) showed that acetic acid, together with very small quantities of higher fatty acids, was always formed during a fermentation without yeast cells. This proves that acetic acid is a true product of fermentation. They

* This number—and subsequent similar numbers further on—appended to the name of the authority quoted, refers to the bibliography at the end of this paper.

assume the presence of a particular enzyme, "glucacetase" in the juice of the (crushed) pressed yeast, which decomposes the sugar into acetic acid. (I would point out here that 1 molecule of a hexose could give 3 molecules of acetic acid.) In view of the above, Duclaux's explanation about the formation of volatile acid by yeast will have to be modified in so far as to admit that, whilst some volatile acid may be formed as he explained, a considerable amount, if not most, is formed through the action of some enzyme, such as the above supposed glucacetase, which is present in the yeast cell. This will explain most of the observations subsequently made, and which will be dealt with as we proceed. Windisch (**7**), in referring to investigations made on this subject by Béchamp, Thylman and Hilger, Kayser, Carles, Becker, Haas, Rocques, and Reisch, states that the sum total of their conclusions amounts to the following:

Different yeasts form, under otherwise identical conditions, different amounts of volatile acid, the beer yeasts forming less than the wine or elliptic and pastorianus yeasts. High temperatures, admission of air, and a lengthy fermentation increase the volatile acids formed. The concentration of the fermenting liquid has no influence. [Subsequent work has certainly disproved this!—A. I. P.] The higher the fixed acidity of the must is, the lower is the volatile acid formed.

He further states that Reisch (**6**) found that the volatile acids rapidly form until nearly half the sugar is fermented out, when their formation soon proceeds much more slowly, and stops altogether when half the sugar has fermented out. Windisch then further states that, when wine matures, the volatile acidity usually increases; that micro-organisms are no doubt mainly responsible for this, although an oxidation of the alcohol, apart from any organisms, does not seem out of the question; further, that a wine's volatile acidity sometimes decreases during maturation.

R. von der Heide (**9**) in 1907 published the results of his investigations on abnormal amounts of volatile acid formed in sweet musts by different yeasts. In his first series of experiments with one wine yeast (Steinberg, 1893) he used a must with the same composition in every case excepting that the sugar rose from 12 to 43 per cent. in the different bottles. After two months the fermentation was over, and the yeast cells were nearly all free from glycogen. The wines were now analyzed for alcohol and volatile acid, and the following were the results obtained:

No. of Bottle	Original Sugar Concentration. Per cent.	Volatile Acid. Per mille.	Alcohol by weight. Per cent.
1	12	0.43	6
2	14	0.50	7
3	16	0.65	8
4	18	0.75	9
5	20	0.75	10
6	22	0.92	10.89

No. of Bottle.	Original Sugar Concentration. Per cent.	Volatile Acid. Per mille.	Alcohol by weight. Per cent.
7	24	1.17	11.19
8	26	1.55	10.52
9	28	1.93	9.92
10	30	1.96	10.52
11	35	2.19	8.35
12	40	2.65	8.35
13	43	2.74	8.42

Here the volatile acidity steadily rose with the sugar concentration of the must, notwithstanding the fact that the alcohol formed got less when 24 per cent. sugar was passed. In order to check these results similar experiments were made with the same and other yeasts with sugar concentrations of 20, 35, and 50 per cent. respectively. Here, as well as in the preceding experiments, the bottles containing the experimental must were sterilized with cotton-wool plugs, and these were replaced by sulphuric acid air-seals only when the yeast had grown so far as to render the must turbid. The following are some of the results thus obtained:

Sugar Concentration.	Steinberg, 1893. Volatile Acid. Per mille.	Piesport. Volatile Acid. Per mille.	Bordeaux. Volatile Acid. Per mille.
20	1.00	0.64	0.69
35	2.12	1.56	1.98
50	5.11	1.78	2.09

These results fully confirm the first ones, whilst they clearly bring out the fact that different yeasts form different amounts of volatile acid. Von der Heide further showed that when experimenting with small quantities of must more volatile acid is formed than when the quantity of must is increased.

In 1912 Osterwalder published the results of some very important experiments he had conducted on the formation of volatile acid by pure cultures of wine yeast. He worked with a number of different wine yeasts which he had isolated and cultivated in pure cultures, and included a standard wine yeast, Steinberg 3, for the sake of comparison. In his first set of experiments he plugged all his bottles with cotton-wool and kept them at the temperature (winter) of the room, which was about 16 deg. C. Half were filled with the juice of the Theiler pear, and half with Sicilian grape-juice. Here I shall consider only the latter. He inoculated with active pure cultures on the 8th October, 1910, and analyzed one lot on the 25th February, 1911, and the remainder on the 1st April, 1911. On the whole the results obtained on these two dates were practically the same, showing that no appreciable amount of volatile acid was either formed or destroyed after the 25th February, when the experiment had lasted four and a half

months. The following extract from the figures given for the analyses made on the 25th February, 1911 (fermentation of grape-juice), will show the great differences between the amounts of volatile acid formed by the different yeasts:

Yeast.	Total Acid as Tartaric Acid.		Volatile Acid as Acetic Acid.	
Sitten 3	5.92	gr. per lit.	1.81	gr. per lit
Dezaley 2	6.15	do.	1.70	do.
Siders 5 (Fendant)	4.95	do.	1.22	do.
Neuenburg 2 (Pinot)	4.50	do.	0.93	do.
Siders 4 (Dôle	4.57	do.	0.76	do.
Chardonnay 1	4.42	do.	0.31	do.
Steinberg 3	3.67	do.	0.19	do.

In most cases a strong new growth of yeast cells was observed overlying the lees as a flocculent layer, which had taken place after the fermentation was over. Osterwalder ascribes the abnormal amounts of volatile acid formed to this pronounced subsequent growth of yeast cells.

He then commenced a new series of experiments with two of the above yeasts that had formed much volatile acid, namely, Siders 5 (Fendant) and Neuenburg 2 (Pinot), and with two that had formed very little volatile acid., namely, Chardonnay and Steinberg 3. Half the bottles were closed with perforated corks having concentrated sulphuric acid air-seals, whereby the air was cut off, whilst the other half were closed with plugs of cotton-wool having a piece of paper tied over them, whereby the air was given fairly free access. The bottles were inoculated on the 12th April, 1911, and kept in a cupboard at summer air temperature. The wines were analyzed towards the end of May, 1911, when the fermentations were over. The original must contained per litre: 162.24 gr. invert. sugar, 2.96 per cent. total acid (as tartaric acid), 0.20 per mille volatile acid (as acetic acid). Further analyses were made in August and October respectively. The following are some of the results obtained:

(1) Where the air was excluded (concentrated sulphuric acid air-seal), the volatile acidity in the case of the four yeasts above mentioned was as below:

Date of Analysis.	Siders 5 (Fendant). Per mille.	Neuenburg 2 (Pinot). Per mille.	Chardonnay 1 Per mille.	Steinberg 3 Per mille.
30 May—14 June	0.36	0.66	0.48	0.67
	30/5/11	30/5/11	14/6/11	3/5/11
8 August, 1911	0.66	0.56	0.60	0.67
17 October, 1911	0.60	0.56	0.70	0.64

On the whole the volatile acidities here found are not high, and on the 17th October they did not differ very materially. The first two even show lower values than the last two.

(2) When the air had access through the cotton-wool plugs, the volatile acidity in the case of the same four yeasts was as follows:

Date of Analysis.	Siders 5 (Fendant). Per mille.	Neuenburg 2 (Pinot). Per mille.	Chardonnay 1 Per mille.	Steinberg 3 Per mille.
23 May, 1911	0.61	0.64	0.47	0.36
4 August, 1911	0.91	0.67	0.42	0.42
4 October, 1911	1.26	0.93	0.41	0.31

Here we see a totally different picture. In the case of the first two yeasts the volatile acidity increased strongly from the 23rd May to the 4th October, whereas in the case of the last two there was a slight decrease. The alcoholic fermentation was much more vigorous where air got access than where it was excluded.

For every determination a different bottle was used, and in every case the wine contained only 2 to 3 gr. sugar per litre, except in the case of Chardonnay 1 (with air excluded), where the wine still contained 10 to 34 gr. sugar per litre.

The following are some of the author's conclusions:—

(1) After the fermentation by pure yeast with access to the air on and in the lees a renewed growth of yeast takes place.

(2) In such cases up to about 1.8 per mille volatile acid (as acetic acid) can be formed in the course of 4 to 5 months in wine kept in small vessels at the temperature of the room.

(3) A small amount of this volatile acid is formed during the fermentation, but the bulk of it is subsequently formed.

(4) As this formation of volatile acid subsequent to the fermentation synchronises with the new growth of yeast on the lees, this latter must be regarded as causing the great increase in the volatile acidity of the wine.

In 1913 Von der Heide and Schwenk (**14**) published the results of their work on the volatile acidity formed by yeast during the refermentation of wine. They tested the effect of the numbers of yeast cells brought into the wine, as well as that of the alcohol and sugar present in the wine at the time of inoculation.

Three series of experiments were conducted where respectively 0.672, 25.12, and 489,600 million yeast cells were introduced into 1 litre of the experimental sterile liquid. Under each yeast concentration there were four groups of three experiments. A pure wine was evaporated *in vacuo* to one-tenth its original volume, when it was brought back to its original volume by adding water and pure alcohol. The latter was added in four different amounts to give four different liquids for the experiments of groups 1, 2, 3, 4, which had to contain respectively 3, 4, 5 and 6 gr. alcohol per 100 c.c. In the case of each group three different amounts of sugar were added to test its influence,

so that there were 12 different experiments for each yeast concentration. After ten weeks the fermentations were over, and the liquids above the lees were quite clear. Each of the 36 samples of lees, taken one from each of the 36 bottles when the analyses were made, was perfectly pure and free from bacteria or *Mycoderma vini.* In every case the alcohol and volatile acid were now determined. The original experimental liquid contained 0.1 per mille volatile acid. Below are given the results for the three yeast concentrations in groups 1 and 4 (*i.e.,* where 3 and 6 gr. alcohol per 100 c.s. liquid were present at beginning of experiments) and for sugar concentrations 1, 2 and 3:

	1st Series.			2nd Series.			3rd Series.		
	1	2	3	1	2	3	1	2	3
1st Group.									
Alcohol gr. per 100 c.c.	6.34	8.49	10.44	6.21	8.42	10.14	6.34	8.28	10.59
Volatile acid, gr. per litre.. ...	0.32	0.30	0.51	0.35	0.42	0.54	0.32	0.43	0.56
4th Group.									
Alcohol, gr. per 100 c.c.	6.90	8.84	10.96	6.99	8.77	10.82	6.53	9.42	10.96
Volatile acid, gr. per litre... ...	0.26	0.31	0.40	0.27	0.31	0.40	0.29	0.35	0.44

From these data we conclude that:

(1) Although the differences are not great, it will still be noticed that in all three series, on comparing the corresponding figures of groups 1 and 4 in each vertical column, the volatile acidity in group 4 is in every case appreciably lower than in group 1. This means that more volatile acid was formed where the initial alcoholic strength of the liquid was lowest.

(2) The increasing amounts of yeast cells introduced, when inoculating series 1, 2, 3, had no influence on the volatile acid formed.

(3) As the sugar concentration in the original experimental liquid rose (columns 1, 2, 3 above), so the alcohol and the volatile acid in the fermented liquid rose. This is in keeping with general experience.

In actual cellar practice conclusion (2) above does not hold good. By adding more active yeast cells of a pure culture to a wine that got stuck, we get a wine with less volatile acid than when only a relatively small number of yeast cells is introduced. Here we are not working under sterile conditions; hence the explanation is that the larger number of yeast cells can keep down the development of acetic and other bacteria, and thus help to keep the volatile acid low.

New Experiments.

I. *Fermentations conducted with Pure Cultures of Different Yeasts and Different Concentrations of Sugar in the Must.*

A. Experiments with Must of 27.9° Balling.—Sterilized must of 22.5° Balling was evaporated on a waterbath till it had

a strength of 27.9° Balling. In nine half-litre bottles 400 c.c. of this must was placed, closed with perforated corks and concentrated sulphuric acid air-seals, and then sterilized for an hour in a steam jacket. This was done in all subsequent experiments. The bottles were inoculated on 27th October, 1916, with two-days'-old cultures of the following yeasts: GFT 1, JJM 1, JJM 2, JJM 5, JJM 6, PJJ 1, Green 1, Green 2, Green 3. The temperature in the thermostat was kept at about 25° C. On the 20th November the fermentation was over in every case, and after the 24th November the loss in weight of the bottles was very slight. The bottles were now analyzed. The results are embodied in

Table I.

	GFT 1	JJM 1	JJM 2	JJM 5	JJM 6	PJJ 1	Green. 1	Green. 2	Green. 3
Loss in weight in gr.	30	40	31	32	27	28	32	33	31
Alcohol in wine, as volume per cent.	9.15	*8.80	9.32	9.74	8.40	8.48	9.78	9.32	10.18
Volatile acid, as gr. acetic acid per litre	2.15	2.26	1.68	1.68	2.21	2.24	1.87	1.94	1.96

These fermentations were incomplete, so that the wine was still sweet. The volatile acid was very high, there being considerable differences between the different yeasts. The initial volatile acidity was very low, being about 0.1 per mille.

B. Experiments with Must of 25.0° *Balling.*—Sterilized must was slightly evaporated to a concentration of 25° Balling. The experiment was otherwise as before. The temperature of the thermostat ran from 22-28° C., being most of the time near 25° C. The bottles were inoculated on 20th January, 1917, with the same yeasts as above, and in addition HeA_3, HaB_3, PB_2. The experimental must used contained 0.14 per mille volatile acid at the beginning of the experiment. The fermentations were over by the 15th February, but, owing to there being no gas, the analyses could not be made until two weeks later. Meanwhile the bottles were kept corked. The following results were obtained:

Table II.

	GFT 1	JJM 1	JJM 2	JJM 5	JJM 6	PJJ 1
Loss in weight in gr.	30	42	44	45	38	39
Alcohol, in wine, as volume per cent...	14.01	14.20	15.16	12.69	15.07	12.97
Volatile acid, as gr. acetic acid, per litre...	1.54	1.50	1.24	1.27	1.72	1.68

	Green. 1	Green. 2	Green. 3	HeA3	HaB3	PB 2
Loss in weight, in gr.	41	36	41	43	36	36
Alcohol, in wine, as volume per cent...	13.72	12.69	13.53	13.91	12.32	12.05
Volatile acid, as gr. acetic acid, per litre...	1.52	1.58	1.52	1.64	0.94	1.22

The fermentations here were fairly complete. The volatile acidity was much less (some 25 per cent.) than in Table I. The same yeasts which gave the lowest volatile acidities in Table I, namely JJM 2, and JJM 5, were also the lowest in this experiment.

C. Experiments with De-sulphited Must of 24.7° Balling.—A must which for nearly a year had been kept from fermenting by adding a large quantity of potassium meta-bisulphite was heated on a water-bath to expel the sulphur dioxide. When nearly all was driven off the must was brought to 24.7° Balling by adding water. The bottles were filled, closed, and sterilized as before. They were inoculated on December 18th, 1916, with the same yeasts as in IA, with the addition of HaC_3. The temperature was that of the room (20-26° C), and the fermentation was rather irregular. On the 16th January, 1917, the fermentation was over, and the analytical determinations were made. The original volatile acidity of the must used was 0.51 per mille, and the free and combined SO_2 were respectively 15 and 127 mg. per litre.

Table III.

	GFT 1	JJM 1	JJM 2	JJM 5	JJM 6
Loss in weight, in gr. . . .	21	21	26	32	29
Alcohol, in wine, as volume per cent....	7.18	7.18	8.31	9.74	7.50
Volatile acid, as gr. acetic acid, per litre	1.02	1.05	1.06	1.50	1.08
	PJJ 1	**Green. 1**	**Green. 2**	**Green. 3**	**HaC 3**
Loss in weight, in gr.	28	36	31	27	28
Alcohol, in wine, as volume per cent...	8.81	10.70	10.00	9.15	8.56
Volatile acid, as gr. acetic acid, per litre..	1.97	1.71	1.67	1.76	1.04

Again, in this case the same two yeasts, JJM 2 and JJM 5, as in Tables I and II, gave the lowest volatile acid, if we except the new yeast HaC_3. The relative positions occupied by these yeasts with regard to the volatile acid formed in all three experiments are very similar, so that they give the same general impression. It was expected that the small amount of sulphurous acid would exert a hindering effect on the alcoholic fermentation, and cause a relatively higher amount of volatile acid to be formed. The above results fully confirmed my expectations. The hindering factor in the first experiment was the great concentration of sugar.

II. *Fermentations with one Pure Culture (HaB_3) and Different Musts at Different Temperatures.*

Sterilized must was slightly diluted and concentrated to give three musts with respectively 20° B., 23.3° B., and 27° B.

Six bottles of each concentration were prepared. Further "moskonfijt" (grape syrup) of 81.9° B. was diluted to 23.4° B. and 12.6° B. respectively. We shall indicate these five experimental liquids in the order above given by the letters P, Q, R, S, T. As each experiment was run in duplicate the two bottles will be indicated by P1 and P2, etc. The original volatile acidities of P, Q, R, S, T were respectively 0.20 per mille, 0.23 per mille, 0.19 per mille, 0.35 per mille, 0.18 per mille.

A. Fermentations at 25° C.—The bottles were filled, closed, and sterilized as before. They were inoculated with an active pure culture of HaB_3 on April 23rd, 1917. The final weights were taken on 10th May, 1917, when the main fermentation was over. The alcohol and volatile acid were then determined.

Table IV.

	P 1	P 2	Q 1	Q 2	R 1
Loss in weight, in gr.	35	34	37	bot. broken.	37
Alcohol, in volume, per cent. . .	11.32	11.50	12.50	..	12.32
Volatile acid, as gr. acetic acid, per litre	0.70	0.70	1.18	..	1.23
Total acid, as gr. tartaric acid, per litre.	6.1	6.3	7.8	..	8.1

	R 2	S 1	S 2	T 1	T 2
Loss in weight, in gr.	30	32	32	18	18
Alcohol, in volume, per cent. . .	12.60	11.14	10.70	6.32	6.47
Volatile acid, as gr. acetic acid, per litre	1.25	1.00	0.98	0.30	0.38
Total acid, as gr. tartaric acid, per litre.	7.0	6.0	5.5	1.2	4.2

B. Fermentations at 30° C.—The bottles were inoculated on 3rd April, 1917, and the main fermentation was over on the 17th April, when the analyses were made.

Table V.

	P 1	P 2	Q 1	Q 2	R 1	R 2
Loss in weight in gr.	38	38	37	38	36	35
Alcohol in volume per cent.	11.68	11.50	12.05	11.77	11.50	11.86
Volatile acid as gr. acetic acid per litre	0.70	0.71	0.91	0.93	1.10	1.20
Total acid as gr. tartaric acid per litre	5.3	5.5	6.4	6.3	6.5	6.5

C. Fermentations at 35° C.—The bottles were inoculated on 19th March, 1917, and on 3rd April, 1917, the main fermentation was over, when the analyses were made.

Table VI.

	P 1	P 2	Q 1	Q 2	R 1	R 2
Loss in weight in gr.	33	32	33	30	32	31
Alcohol in volume per cent.	10.09	10.09	10.35	10.35	9.57	9.57
Volatile acid as gr. acetic acid per litre	0.74	0.73	0.95	0.95	1.18	1.18
Total acid as gr. tartaric acid per litre	5.3	5.5	6.2	6.4	7.8	7.2

D. Fermentations at 40° C.—The bottles were inoculated on 13th June, 1917, and the fermentation, which was slow and feeble, was over on 23rd June, 1917, when the analyses were made. Only one bottle was taken for each concentration of the must, and the loss in weight of the bottles was not recorded.

Table VII.

	P	Q	R
Alcohol in volume per cent.	5.33	5.55	4.88
Volatile acid as gr. acetic acid per litre ..	0.70	0.84	0.90
Total acid as gr. tartaric acid per litre ..	5.4	6.4	7.2

The wines were still very sweet when analyzed.

III. *Experiment to determine at which Stage of the Fermentation the Volatile Acid is Formed.*

A bottle containing 400 c.c. of must at 22.5° Balling was inoculated with a pure culture of HaB_3 and kept in the thermostat at 40° C. The fermentation was feeble. The volatile acidity three days after the fermentation commenced was 0.94 per cent., the next day it was still 0.94 per cent., and 10 days after the fermentation had commenced it was 0.96 per cent. This shows that the bulk of the volatile acid formed by the yeast was formed during the early and stormy part of the fermentation.

Discussion of Results.

In order to be able better to compare the amounts of volatile acid formed in the different experiments, I shall now regroup the results in one table, giving the actual amounts of volatile acid formed, as well as the amount of volatile acid formed per 100 volume per cent. alcohol formed at the same time. In the case of the duplicates in Tables IV to VI the mean values are given.

Table VIII.

Yeast.	Alcohol Formed in Volume, per Cent.	Volatile Acid Formed, per Mille.	Volatile Acid Formed, per 100 Volume per Cent. Alcohol Formed.
Table I:			
GFT 1	9.15	2.05	22.40
JJM 1	8.89	2.16	24.30
JJM 2	9.32	1.58	16.95
JJM 5	9.74	1.58	16.22
JJM 6	8.40	2.11	25.12
PJJ 1	8.48	2.14	25.24
Green 1	9.78	1.77	18.11
Green 2	9.32	1.84	19.74
Green 3	10.18	1.86	18.27
Table II:			
GFT 1	14.01	1.40	9.99
JJM 1	14.20	1.36	9.59
JJM 2	15.16	1.10	7.26
JJM 5	12.69	1.13	8.90
JJM 6	15.07	1.58	10.49
PJJ 1	12.97	1.54	11.10
Green 1	13.72	1.38	10.06
Green 2	12.69	1.44	11.34
Green 3	13.53	1.38	10.20
HeA_3	13.91	1.50	10.78
HaB_3	12.32	0.89	7.22
PB_2	12.05	1.08	8.96
Table III:			
GFT 1	7.18	1.41	19.64
JJM 1	7.18	1.44	20.01
JJM 2	8.31	1.15	13.84
JJM 5	9.74	1.68	11.09
JJM 6	7.50	1.47	19.60
PJJ 1	8.81	1.46	16.57
Green 1	10.70	1.20	11.22
Green 2	10.09	1.16	11.50
Green 3	9.15	1.25	13.66
HaC_3	8.56	1.13	13.20
Table IV:			
P	11.41	0.59	5.17
Q	12.59	0.95	7.55
R	12.51	1.05	8.39
S	10.97	0.64	5.91
T	6.40	0.69	2.97

Yeast.	Alcohol Formed in Volume, per Cent.	Volatile Acid Formed, per Mille.	Volatile Acid Formed, per 100 Volume per Cent. Alcohol Formed.
Table V:			
P	11.59	0.51	4.36
Q	11.91	0.69	5.79
R	11.68	1.01	8.61
Table VI:			
P	10.09	0.54	5.30
Q	10.35	0.72	6.96
R	9.57	0.99	10.35
Table VII:			
P	5.33	0.50	9.38
Q	5.55	0.61	10.99
R	4.88	0.71	14.55

On comparing these results, it will be seen, considering Tables I. to III. as a group, that the highest amounts of volatile acid were found in Table I. where the sugar concentration was highest. This is in complete agreement with the results above quoted from R. Von der Heide's experiments on the same subject. Further, we notice that in Table II. the highest amounts of alcohol were formed, whereas in Table III., where a must of practically the same sugar concentration was used, very much less alcohol was formed owing to the presence of some sulphur dioxide, which, under the conditions of the experiment, prevented the fermentations from going very far. The amounts of volatile acid here formed do not differ much, on the whole, from those given in Table II., but owing to the much smaller amounts of alcohol formed in the former case, the amounts of volatile acid formed in comparison with the corresponding amounts of alcohol formed are much bigger than those given in Table II. Thus the hindering effect of the sulphur dioxide on the alcoholic fermentation, and the consequent increase in the amount of volatile acid formed, is clearly shown on comparing the last vertical column of Tables II. and III. This, again, is in perfect agreement with Duclaux's assertion, quoted early in this paper, that when yeast grows and lives under adverse circumstances it forms more volatile acid than would be the case under more favourable conditions.

Coming to Tables IV. to VII., we do not find very high volatile acidities, as the yeast used in these experiments, namely HaB_3, is not one that tends to form much volatile acid. In Table II., where it was compared with 11 other yeasts, it formed the smallest amount of volatile acid, even in comparison with the alcohol formed. Still, on comparing the results enumerated in

Tables IV. to VII., we notice how in every case the volatile acid formed rises with the sugar concentration of the must. This still holds good when we consider the amounts of volatile acid formed in comparison with the corresponding amounts of alcohol formed in each case. If we now consider the influence of temperature, we find that, whilst there is on the whole not much difference between the results obtained at 25 deg. and 30 deg. C. respectively, there is a decided drop in the amounts of alcohol formed at 35 deg. C., whilst the volatile acid formed still remained about the same as before. At 40 deg. C. the fermentation was in every case very feeble, so that only about half as much alcohol was formed as at 35 deg. C., whilst the volatile acid formed, though less than at 35 deg. C., has not diminished to any large extent. The obvious result is that the largest amounts of volatile acid in comparison with the alcohol were formed at 40 deg. C. *Hence a high temperature (beyond 35 deg. C.) during the fermentation causes the yeast to form very considerable amounts of volatile acid in comparison with the alcohol formed at the same time.* As was found in experiment III., the bulk of the volatile acid formed by yeast is formed in the early (stormy) part of the fermentation. This agrees with the findings of Reisch quoted above. The "moskonfijt" does not seem to have any special influence in experiment II. A., where it was used.

Some Practical Considerations.

Apart from the scientific interest attached to the subject of the volatile acidity of wine, it is also of great practical importance and value to those engaged in the making, manipulation, and sale of wine. One question that could be put from this practical point of view is *whether the amount of volatile acid found in a wine by chemical analysis is any criterion as to its state of soundness.* In this country certain rules have been laid down by the Western Province Agricultural Society as to the maximum amounts of volatile acid that are allowed in show wines. Further, most wine merchants of the Western Province regard wines with higher volatile acidities than these as only fit for distillation, or at any rate as unsound, and will only buy them at the price paid for distilling wine. The facts that have been brought to light in this paper show clearly that the volatile acidity of a wine may be due to various causes. In any case, under certain circumstances, a fermentation with pure wine yeast can produce a high volatile acidity in a wine without any action of acetic or other bacteria coming into play at all. Now, if the volatile acidity is mainly due to yeast and not to bacteria, it will not increase to any dangerous extent as the wine matures, and need not be taken as such a dangerous indication as to the wine's soundness. If, however, it is due mainly to the action of acetic or other harmful bacteria, it should certainly be taken as a warning with regard to the future treatment of such a wine. We therefore need more than a mere chemical determination of the volatile acidity of a wine in order to be able to say definitely in every case

whether the wine is sound or unsound. A bacteriological examination and tasting by a connoisseur should be added to the chemical determination of the volatile acidity of a wine.

With regard to the value of *tasting*, Mathieu (**11**) points out that the volatile acids influence both the bouquet and the taste of a wine. He says further:

A connoisseur can soon tell whether a diseased wine suffers from an acetic fermentation, or "tourne" (acetic and propionic acid), or rancidness (butyric acid). If the wine contains carbon dioxide, the volatile acid will seem more on tasting that it is in reality. This is very noticeable before and after impregnating a wine with carbon dioxide. On tasting, the impression obtained about the volatile acid depends upon—

(1) The amount of volatile acid present;
(2) The nature of the volatile acids;
(3) Certain other constituents of the wine, of which alcohol and saccharine substances tend to diminish or cover it, whilst the fixed acids and carbonic acid tend to exaggerate it.

Hence tasting alone is not sufficient. Chemical analysis alone will not do either. Both combined must be used. Tasting will show: (*a*) Whether the wine is perfectly sound; (*b*) whether its soundness is doubtful; (*c*) whether it has decidedly gone wrong. Analysis will discover any deception under (*a*), decide (*b*), or confirm (*c*), if a comparison is made between the wine in question with sound wines of the same nature. *It is not possible to lay down definite limits for the volatile acidity as a means of determining the soundness of all wines.* (The italics are mine.—A. I. P.) In doubtful cases a comparison should be made with sound wines of the same class.

Wortmann (**8**) also points out how alcohol and sugar cover the volatile acidity on tasting, but differs from Mathieu, where he ascribes a covering effect to a high total acidity of a wine, whilst the latter maintains that it tends to magnify the impression gained about the volatile acidity of the wine on tasting. Wortmann points out how easily a fairly low volatile acidity is noticeable on tasting a thin and light wine. He therefore recommends that, in doubtful cases, the wine be somewhat diluted with water so as to be able to detect the volatile acids more easily.

We shall now briefly consider what *limits of volatile acidity in wines* have been proposed by different people to classify wines as sound or unsound according to this criterion. Mathieu (**11**) states that, in wines with a *normal* taste, the volatile acidity varies from 0.21 to 1.22 per mille, according to districts, years and age. Possetto (**3**) quotes 2 to 2.5 per cent. as general limits for the volatile acidity of wine. Röttger (**10**) states the following: "The free 'Vereinigung bayrischer Vertreter der angewandten Chemie' in 1897 adopted the following standards for the volatile acidity of wines, on the proposal of W. Möslinger:

(*a*) As normal are to be considered a volatile acidity of 0.9 per mille for German white wines and 1.2 per mille for German red wines.

(*b*) As no more normal, but not yet to be condemned, are German white wines with a volatile acidity between 0.9 per mille. and 1.2 per mille., and German red wines with a volatile acidity between 1.2 and 1.6 per mille.

(*c*) German white and red wines with more than 1.2 per mille. and 1.6 per mille. volatile acidity respectively should not be sold for consumption, even if tasting discloses nothing abnormal.

(*d*) A wine is to be condemned as unfit for consumption if its volatile acidity exceeds 1.2 mille and 1.6 per mille. in the case of white and red wines respectively, *and if tasting corroborates this* (the italics are mine.—A. I. P.).

(*e*) German 'Edelweine' (liqueur wines) and wines which have matured for over 10 years in wood are exempted from (*a*), (*b*), (*c*) above. Their volatile acidity must be specially judged in each case."

He further states that the United States' "Standards of Purity for Food Products" put 1.2 per mille and 1.4 per mille as the maxima of volatile acid for white and red wine respectively. Wortmann (**8**) considers that white wines with 0.9 per mille to 1.2 per mille volatile acid and red wines with 1.2 per mille to 1.6 per mille volatile acid should be regarded as diseased. He further states that according to the German "Nahrungsmittelgesetz" (Foods Act) white wines with over 1.2 per mille volatile acid and red wines with over 1.6 per mille volatile acid are regarded as diseased, and not fit for consumption if the tasting also proves them conclusively and without a doubt to be diseased ("verdorben"). This means that in the case of liqueur wines the limits allowed will be somewhat higher than above stated, as the sugar will largely cover the volatile acids.

From the above it will be clear that, in laying down limits for volatile acidity in sound wines, differences should be made between white and red, dry and sweet, light and strong, young and old wines; the higher limit being fixed always in the second case. But in addition to this the decision, in cases of any doubt, should always be confirmed by tasting.

For South Africa I would, from personal local experience, favour some such limits as were proposed by Möslinger in 1897 as quoted above from Röttger.

In conclusion, I would just mention that the volatile acids in sound wines are, according to Babo and Mach (**12**), mainly acetic acid together with smaller quantities of butyric, capronic, caprylic, pelargonic, lactic, and formic (usually minute quantities only) acids. In the case of diseased wines also propionic and valeric acids occur amongst the volatile acids.

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(**14**) C. von der Heide u. E. Schwenk, "Ueber die Bildung von flüchtigen Säuren durch Hefe bei der Umgärung von Weinen," Landw. Jahrbücher **45** (1913), 117-120.

(*Read, July* 5, 1917.)

SULPHATE OF AMMONIA.—The *South African Journal of Industries* states that over 250 tons of sulphate of ammonia are now being manufactured monthly at Vryheid, Natal, and the output will probably increase to 350 tons by the end of 1918. Anthracitic coal is being used, and so there are no tar products of any importance. The coal is treated in Mond Producers, and is entirely gasified. The ammonia is washed out of the gas, which, with the exception of a portion used for boiler firing, is blown to waste. Sulphuric acid is also being manufactured from pyrites obtained from the Rand, but the full capacity of the plant—400 tons per month—has not yet been reached.

STENOGRAPHY AS AN AID TO THE PHONETIC ANALYSIS AND COMPARISON OF AFRICAN LANGUAGES.

By Rev. William Alfred Norton, B.A., B.Litt.

(With two text figures.)

Often in hearing cases of discipline I have felt the need of a system of shorthand. At last I evolved, on much the same principles as those of Pitman and others (though none of these are applicable completely to the languages we are considering), a system which should suit the Bantu languages. The result was rather interesting to my natives. In our Church Councils they might be inclined at first to complain, seeing me scribble when I should be attending to their remarks, but when they challenged my version of these, I could read out the very words they had said, and convince them that I was doing them only too much justice.

It was in the Gale Hills, opposite Amani ("Peace"), the lovely Botanical Station the Germans had founded, and which stands not far from the Tanga line, some 30 or 40 miles up, and some 17 miles from our English mission station. This latter had been there before the Germans' arrival, but had been left, with our usual insular blindness the wrong side of the boundary.*

The vista of broken precipice and palmy forest stretched away to the sea, and framed the Island of Pemba, standing leagues off in the Indian Ocean. I sat actually shivering, one "winter's day," 4 deg. south of the equator, and took down evidence given before one of my colleagues in Bondei, a dialect I did not know, in this same shorthand. I was surprised to find that my friend was able to recall the evidence, when I spelt out my phonetic signs in ordinary letters. With this introduction the system adopted presumes to make its humble salaams. If it should be of any use to missionaries, soldiers, doctors, traders and others, who have to do with native tribes, it will give me much pleasure.

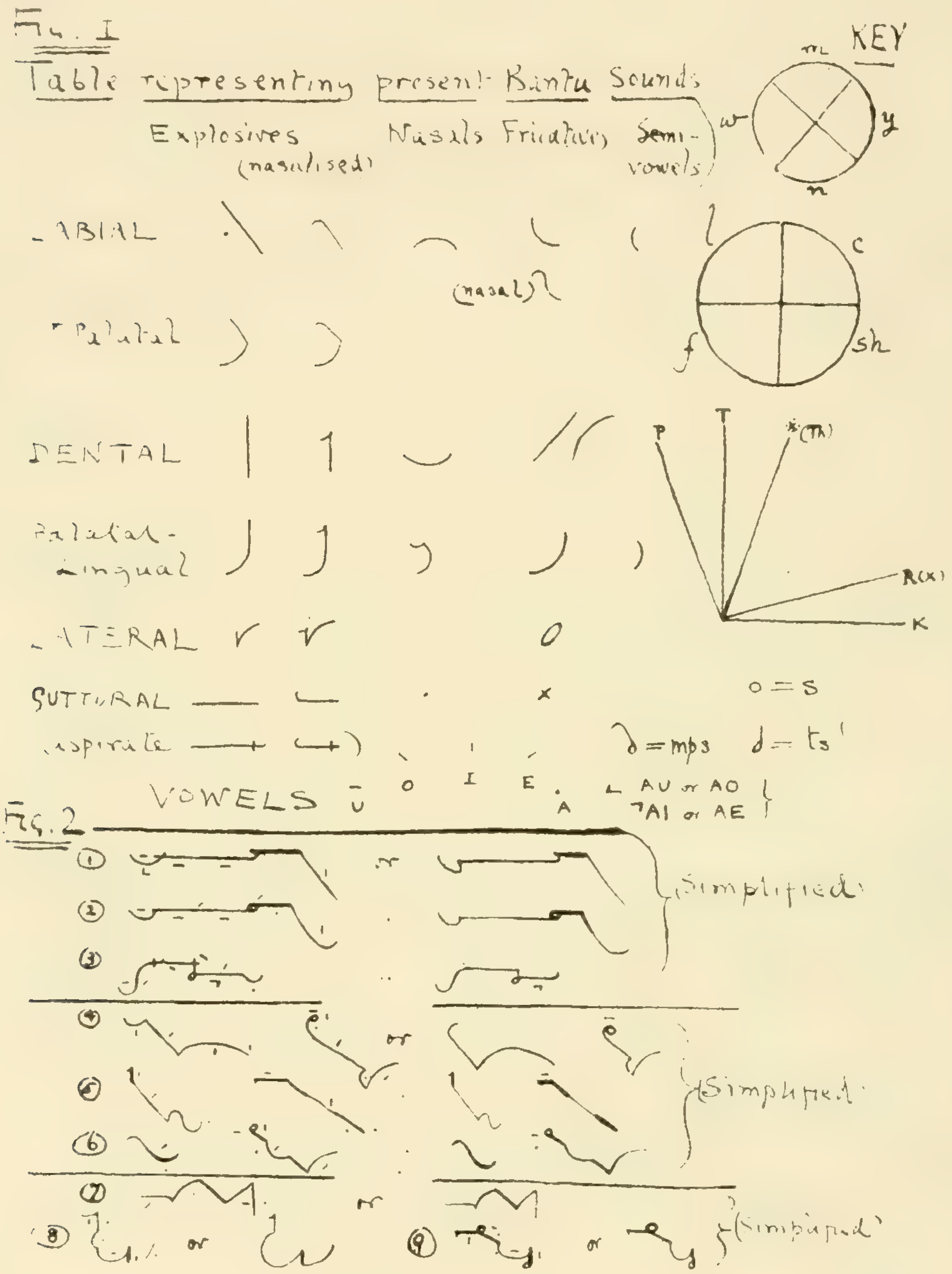
Fig. 1 gives the alphabet, arranged phonetically. The small circle is S as usual, but, compressed to a sloping oval, is the Hl of Suto-Zulu-Xosa, the Welsh Ll, written by Meinhof, in some of his books, as a modified S. Thickened, it will be the kaffir Dl.

The slope marked * is left free for Swahili Th and its flat (thickened). In the Southern languages, which have not this (doubtfully Bantu) sound, it is free for the Q palatal click.

* When shall we learn to study native conditions? The Germans have done so with great effect. Witness the use they made of their natives in the East African campaign.

The converse of F, sometimes used in Pitman for R, is used in my system for the C, or dental *click* in Zulu-Kaffir; while the other R is used by me for the X, or lateral *click*, in the same dialects, but remains R in Suto, etc.

Combined letters are made half size. *Cf.* the small tick for Tl, composed of half T and half L, and the nasalized sounds nT and mP.



Doubled letters are twice as large, except in the case of N and M, which are thickened, leaving the doubling to represent two N's or two M's separated by a vowel.

Thickening usually voices a letter, as in Pitman, but this does not apply to the already voiced nasals.

The *aspirate* may usually be omitted in combination with sharps, as it is in the common spelling of Swahili and Zulu-

Kafir; nor are the Kaffir sharps distinguished from the Suto, as strictly they should be (as also the two kinds of B).

Cerebral letters are not distinguished from the dental, but D is used for the cerebral L in Suto, which is now usually pronounced D.

It is obvious that a practical shorthand method for hurried use must dispense with the finer distinctions required in a complete phonetic alphabet. The most that can be required from it is that it shall be along phonetic lines. That my system is so is clear from the figures. That it is workable I have found in practice.

There is little to be added. Though . is *ng* in *sing*, yet when followed by *k* or *g*, it takes the ordinary half-*n* hook, as given: otherwise it would hardly be visible. It is the same in English, as well as Bantu, longhand; we write *ink*, not *ingk*. This nasal . is attached to the consonants of the adjacent syllables, and is thus distinguished from .(\), which always stands alone. The *vowels*, unless initial, are usually omitted, as in Pitman and Arabic, etc.; but dipthongs should be inserted.

When adjacent consonants *cross*, a syllabic H is understood between them (as *fchelo*, against *fala* in Suto). The small cross for H is thickened for stronger fricative gutturals like the Dutch *g* = Xosa *r* Zulu *hh*.

Fig. 2 gives *examples*, illustrating graphically the philological closeness of remote Bantu dialects. I add the Dutch, as well as the English, in some cases, to show how much closer are remote Bantu than neighbour Low-Dutch languages. The Bantu illustrations run thus:—

1	4	Swahili	8	
2	5	Xosa	9	(Zulu)
3	6	Suto	7	

1. U nao khuku ngapi?
2. U nenkuku ezingapi na?
3. U na le khoho tse kae na?

   You have fowls, how many?
   (Hoe veel hoenders het jij?)

---

4. Nipe mimi, usiwape wale.
5. Ndipe mna, ungabapi abà.
6. Mpe nna, usebafe bale.

   Give to me, don't give to them.
   (Geef ver mê, geef nie ver hullie nie.)

---

7. Ke tla ba ruta.
8. Ni ta wa fundisha.
9. Ngi zo ba fundisa.

   I will them teach.

7 (Suto) illustrates the eccentricity of the consonants of the central dialects of South Africa. 8 and 9 the constancy of the coastal dialects. Suto has R for Z-X. F, and T for nD.

I beg to acknowledge, as usual, the help of Meinhof, and also the standard works in Kaffir, as those of Mr. McLaren. Also, in this case, of the great system of Pitman.

TRANSACTIONS OF SOCIETIES.

South African Institution of Engineers.—Saturday, October 13th: G. M. Clark, M.A., A.M.I.C.E., President, in the chair.—"*The factor of safety of wire ropes used for winding in mine shafts*": J. A. **Vaughan.** The subject was mathematically investigated by the aid of graphic diagrams, and simple formulae of safety sought.

Saturday, December 8th: G. M. Clark, M.A., A.M.I.C.E., President, in the chair.—"*Description of the works of White's South African Cement Company*": H. **Campbell.** The works are situated at Ventersburg Road, Orange Free State. The description included the power plant, laboratory, repair shop, limestone quarry, aerial ropeway, wet mill, mixer, kiln plant, coal plant, cement mill, and silos. The consumption of water on the works is approximately 65,000 gallons per 24 hours, obtained from the company's concrete dam at Rietspruit.

Saturday, January 12th, G. M. Clark, M.A., M.I.C.E., President, in the chair.—"*A liquid speedometer*" W. **Alexander.** The type of speedometer described was found to overcome the objections usually attaching to those of the revolving mass type. The instrument consists of an impeller, a casing, an accurate means of measuring liquid pressure or head, and a liquid reservoir.

Geological Society of South Africa.—Tuesday, December 18th: J. J. Garrard, Vice-President, in the chair. "*Note on a remarkable occurrence of chromium tourmaline and rutile in the Barberton District*": A. L. **Hall.** A very peculiar association of green chromium tourmaline, with pink rutile occurs in the neighbourhood of Noordkaap, nine miles north of Barberton: apparently a rock of this unusual combination has not previously been recorded. The author proceeded to describe in detail the occurrence recorded by him.

Chemical, Metallurgical, and Mining Society of South Africa.—Saturday, March 16th: G. Hildick Smith, President, in the chair.—"*The estimation of injurious dust in mine air by the Kotze Konimeter*": J. **Innes.** The konimeter is a simple mechanical arrangement for causing a known quantity of air to impinge at a high velocity through a fine nozzle on to the surface of a glass slide thinly coated with vaseline. The spot so formed is preserved by means of a cover-glass, and the number of particles counted under a microscope by means of a specially ruled glass.

Female.

Hermaphrodite.

Male.

F. W. Petty. Hermaphroditism in *Metruastra pithyocnysa*.

HERMAPHRODITISM IN *METANASTRIA PITHYOCAMPA* CRAM.

By Franklin William Pettey, B.A.

(*Plate* 12.)

Young lepidopterous larvæ were found in a cluster feeding on the leaves of an oak-tree at Elsenburg, Mulder's Vlei, Cape Province, in April, 1916.

The transformation into the cocoon stage did not occur until the 1st of December. Six moths emerged several weeks later. On spreading the wings of the moths for museum specimens, the writer noticed that in one specimen the right wings were larger than the left. Closer examination revealed the fact that it was a case of longitudinal hermaphroditism, the smaller wings (left side) being characteristic for the male, and the larger (right side) for the female. The left antenna was characteristic for the male, and the right one for the female. Even the abdomen was divided sexually into right and left halves, as evidenced by the greater pubescence and the darker colour characteristic of the male.

A male moth was found attached caudally to the hermaphroditic insect apparently in the act of copulation.

Folsom states that "the phenomenon of hermaphroditism occurs only as an extremely rare abnormality among insects. Speyer estimated that in Lepidoptera only one individual in 30,000 is hermaphroditic. Bertkau (1889) listed 335 hermaphroditic arthropods, of which 8 were crustaceans, 2 spiders, 2 Orthoptera, 8 Diptera, 9 Coleoptera, 51 Hymenoptera, and 255 Lepidoptera. The large proportion of Lepidoptera is due in great measure to the fact that they are collected oftener than other insects (excepting possibly Coleoptera), and that sexual dimorphism is so prevalent in the order that hermaphrodites are easily recognized. The most common kind of hermaphroditism is that in which one side is male and the other female. . . . In other instances the antero-posterior kind may occur, as when the fore-wings are of one sex, and the hind-wings of the other; rarely the characters of the two sexes are intermingled. Hemaphroditic insects are such rarities that very few of them have been sacrificed to the dissecting needle in order to determine whether the phenomenon involves the primary organ as well as the secondary sexual characters. When dissections have been made it has been found usually that hermaphroditism does extend to the reproductive organs themselves. Thus a butterfly, with male wings on the right side and female wings on the left, would have a testis on the right side of the abdomen and an ovary on the left side."

(*Read, July* 6, 1917.)

A

THE RESPIRATORY RECTUM OF THE NYMPH OF *MESOGOMPHUS* (ODONATA).

By Stephen Gottheil Rich, M.A.

(With eight text figures.)

Mesogomphus, represented by two species and a large number of individuals, is a familiar dragonfly of South Africa. The adult is a medium-sized green and black dragonfly, with clear wings. It is not to be confused with *Hemianax* and *Aeshna*, the larger green dragonflies that are rarely seen to alight. *Mesogomphus*, like all Gomphinæ which I have observed, is very much given to the habit of resting on warm rocks in the sun. The males are at once recognizable from all other dragonflies by the enlarged terminal portion of the slim abdomen.

The nymph of this genus is, so far as I can tell, undescribed. My specimens are taken from a part of the Amanzimtoti river in Natal, in which the only adult Gomphinæ found are the two species of *Mesogomphus*. The nymph runs out accord-

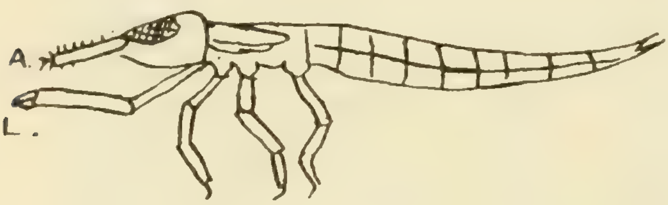
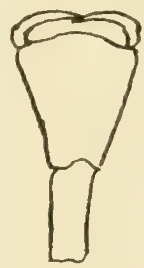


Fig. 1.
(Labium extended.)
A. Antennæ
L. Labium.



Labium.

ing to the keys of Needham, 1901, and Rousseau, 1909, for North American and European species in this sub-family to *Ophiogomphus*. This genus, however, is not known in the Ethiopian region, but is in adult characters the closest to *Mesogomphus*. I have therefore no hesitation in identifying this nymph without waiting for bred specimens to mature.

Like all Gomphinæ, this flat nymph is a burrower in sandy or muddy bottoms. It there lies in wait for prey, only its anal breathing valve and the tips of the eyes and antennæ in view. It catches its prey, like all Odonate nymphs, by shooting out the long, jointed, arm-like labium.

In 1914 and 1915 the present writer studied the respiratory organs of 21 genera of Odonata represented in North America, including the genera *Lanthus*, *Gomphus*, and *Ophiogomphus*, closely allied to *Mesogomphus*. In a previous paper* I have published a brief summary of my results so far as they apply to our South African genera of Odonata. In that article I added to

* Rept. S.A. Assoc. for Adv. of Science, Maritzburg (1916), 600-602.

my North American work studies of several South African Odonata. I there discussed a Gomphine nymph, which I took to be *Mesogomphus*. Later work has shown me that this identification was not correct, and that the nymph in question was most probably *Podogomphus*. Having, however, material which is almost surely Mesogomphus, I studied it, and have embodied the results in this paper.

The nymphs of all the Anisoptera, or dragonflies proper, breathe by a means of a highly specialized respiratory rectum. The rectum is provided with tracheal gills, from which the oxygen dissolved in the water passes by diffusion into the tracheæ of the insect. The gills are curious in that they are not blood-gills as in most aquatic animals, but purely tracheal gills. The exchange is not of dissolved gases between water and blood,

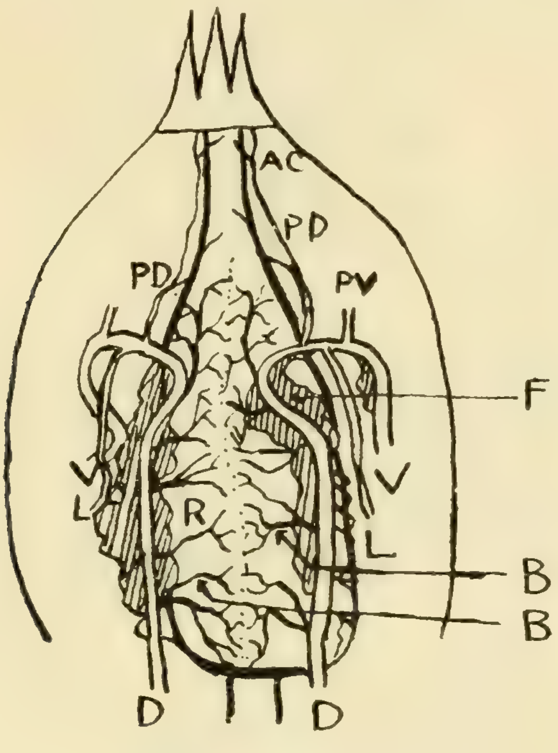


Fig. 2.—Dorsal View.

but of oxygen inwards and carbon dioxide outwards, between the water and the air in the tracheæ.

Figure 1 shows the nymph in question.

Figure 2 shows the appearance of the caudal part of the abdomen with the dorsal wall removed. The large tracheal trunks, DD, correspond to the dorsal tracheæ of most insects, but are much enlarged. As in many nymphs of Odonata, the fat-body is in the specimens which I studied, closely adherent to the tracheal trunks. From these trunks there pass to the rectum the many small branches, BBB. These divide and re-divide as they pass to the rectum. The dorsal trunks loop back into a similar pair of ventral trunks, likewise an enlarged form of the usual tracheæ of the insect body. At the point where they loop

back, the lateral tracheæ, likewise a normal structure and here in no wise enlarged, join the dorsals. VV are the ventral trunks, and LI the laterals.

At this point there is given off a special trachæ, the postdorsal, on each side. This passes back to the caudalmost part of the digestive tract and to the caudal appendages. The postdorsals are shown as PD in Figure 2.

The distribution of tracheæ is similar as regards the branches from the ventral trunks. There is a postventral also on each side, passing to the caudal end of the rectum. See figure 3.

The enlarged hollow organ, R, is the rectum or gill chamber. It lies in the seventh to ninth somites of the abdomen. The last abdominal somite is occupied by a plain canal, the anal canal, AC, which is not respiratory.

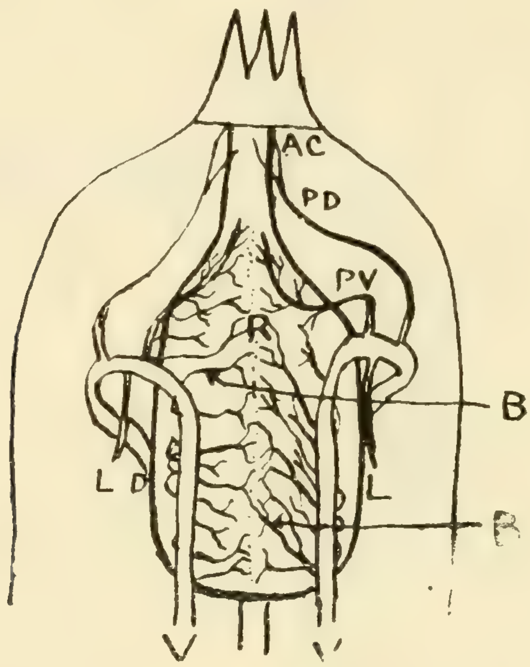


Fig. 3.—Ventral View.

It must be noted that the dorsal trunks are larger than the ventrals, and have many more branches. In both trunks there arise branaches on both sides of the trunk. The larger size and greater branching of the dorsal trunks is explained by the fact that branches from them pass to two-thirds of the area of the rectum, while only the ventral third is connected to the ventral trunks.

Figure 4, a cross-section of the rectum and trunks, shows this distribution plainly.

The outside of the rectum has upon it six dark longitudinal lines, along which the tracheal branches enter it. These lines are the bases of the gill-folds within the rectum, and their necklace-like character is caused by the occurrence of bases for definite gills within the rectum. Between the rows of gill-bases

are longitudinal bands of muscle, M. Figure 4 shows these details.

If we open the rectum, we shall find within it a mass of thin white filmy folds. There are six longitudinal folds, which lie loosely, and are much folded upon themselves. They appear in cross-section in Figure 5, LF. Arranged alternately along each side of the longitudinal folds, at the base of these, are 20 of what I may call buttress folds, adopting the terminology from another genus. These leaf-like folds, BF, which are of the shape shown in figure 5, hang loose within the rectum.

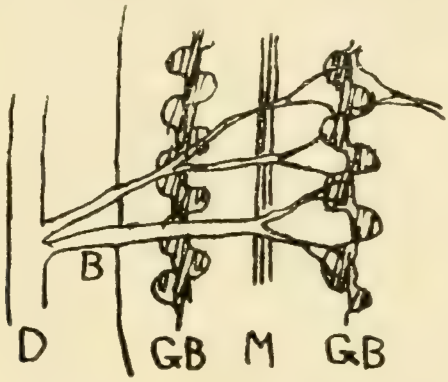


Fig. 4. Detail of Fig. 2.

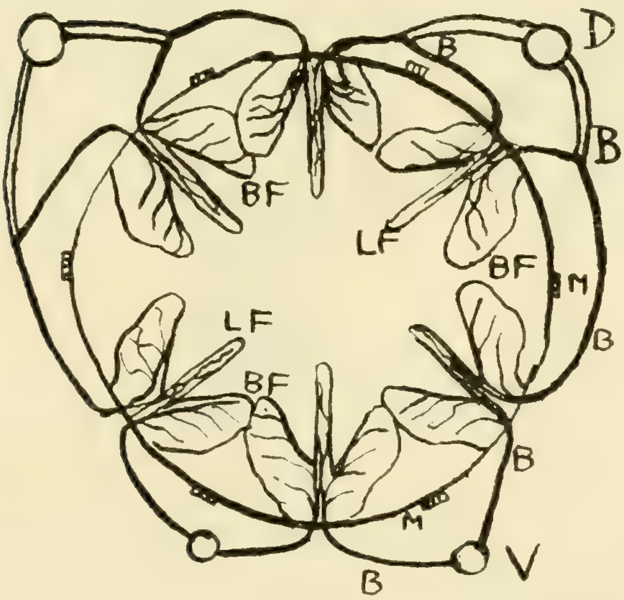


Fig. 5.—Cross-Section.

All the folds are respiratory organs. They are all filled with a network of repeatedly-branching tracheoles, which become finer and finer as they approach the edge of the folds. Near the edge they form an immense number of recurving loops. These loops are not blind, but lead back again into the larger tracheal branches. Sadones, 1895, has shown that for other species of dragon-flies these loops are actually imbedded in the epithelium of the folds or gills; and I have reason to think

that this is true for all species. Figure 6 shows the folds and their tracheation, and Figure 7 a bit of the margin of a fold, with its tracheal loops. In Figure 5 the buttress folds appear.

In the base of each buttress fold, where it joins the longitudinal fold, is a bit of fatty tissue, F. This feature I have found in all genera studied by me, save one. Likewise, there is on the cephalic side of the gill a tough "cushion," C, of thick epithelium. This also is a constant feature. I am not aware that the function of these parts is known.

The buttress folds are not set at right angles to the longitudinal folds, but are skewed cephalad. They hang in the rectum with their points directed cephalad.

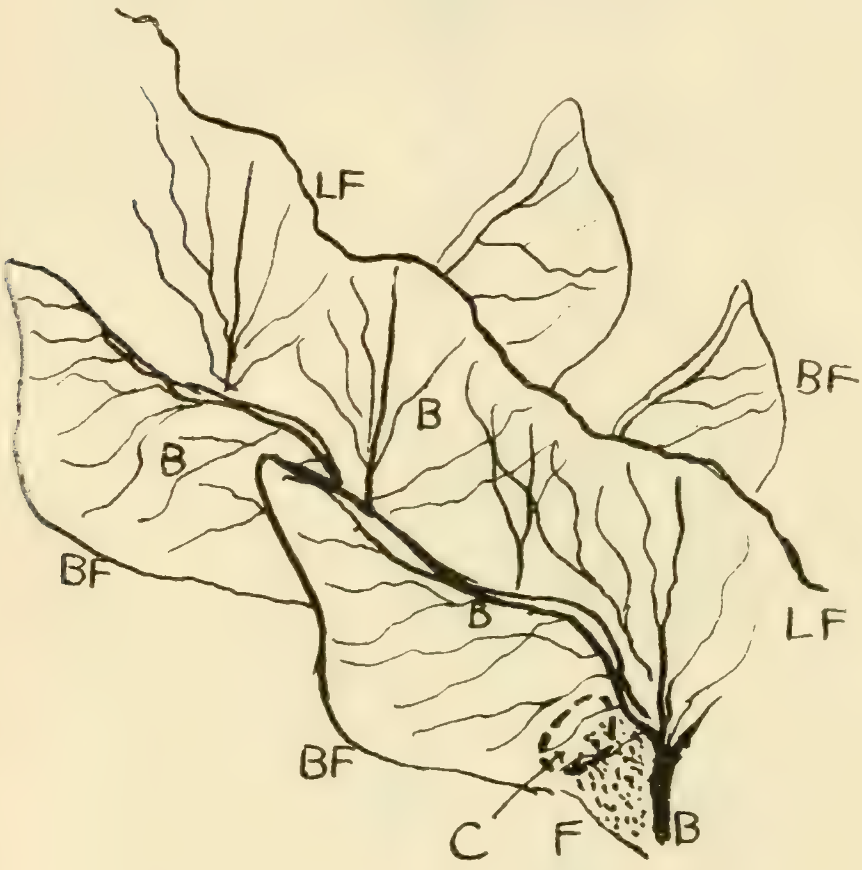


Fig. 6.

The respiratory rectum, with its delicate parts, is not freely open to the water at all times. Hidden under the five terminal appendages of the abdomen is a valve of three membranous folds, which may be closed at will by the animal. I have seen the nymph of *Libellula* open and close this valve continuously and rapidly when in water with particles of dirt in it.

The respiratory rectum is connected in *Mesogomphus* as in all Aeshnidæ, with the anus by a canal, AC, occupying the tenth abdominal somite. In the sixth somite a broad band of muscle passes over the intestine, and appears to act as a valve to keep the water out of the digestive part of the alimentary canal. In specimens of various genera I have found this band clamped down hard on to the intestine.

The respiratory rectum serves also as a swimming organ. By ejecting its contents suddenly, the nymph propels itself forward in a jerky fashion. This may easily be seen in the nymph of any dragon-fly, if put into clear water and disturbed.

It is somewhat interesting to compare this rectum of *Mesogomphus* with that of other dragon-fly nymphs. Except for details of distribution of the tracheal branches, there is no great difference between the external appearance of the rectum in all the species of dragon-fly thus far studied. The Libellulidæ lack the anal canal; their rectum narrows abruptly to the valve.

The differences between the nymphs of different species are found in the character of the gills. The accepted genera seem to agree with the variations in gill-character.

In the Aeshnidæ, we find much variation in gills. The Gomphinæ have, in the main, gills quite different from those of *Mesogomphus*. *Hagenius*, *Gomphus*, and *Ophiogomphus*, genera of Europe and North America, have, instead of folds,

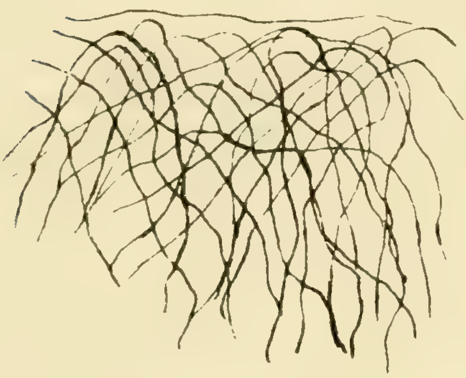


Fig. 7.

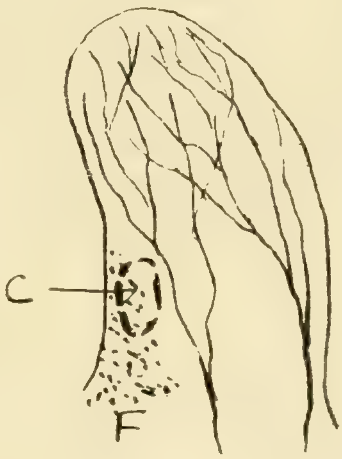


Fig. 8.

tufts of villi filled with loops of tracheæ. Lanthus, of North America, has folds almost identical with those of *Mesogomphus*. Ris, 1913, reports for *Gomphus pulchellus* of Europe and for *Onychogomphus* a combination form, with villi on the crests of the folds. This, however, I did not find in the North American species of *Gomphus*, which I studied; nor have previous workers found it. In the Aeshninæ there is also variation. *Aeshna*, *Basiaeshna*, *Boyeria*, have folds much like *Mesogomphus* has, but with much enlarged buttress folds, which are true buttresses for the main folds. Anax had villi, but they are short and on the crest of small longitudinal folds. *Cordulegaster*, the one genus of the Oordulegasterinæ, has folds like *Aeshna*. This is reported for several Nearctic species by different workers.

The Libelliludæ I have discussed in my previous paper. Figure 8 shows a gill of *Orthetrum* sp. found in the Amanzimtoti River. There are from 200 to 360 gills in the rectum, the number varying with the species. Earlier writers.

such as Oustalet, 1869, and even Scott, 1905, asserted that there were fifty thousand gills in a Libellulid rectum. My counts reduce this somewhat.

I might add that the greatest number of respiratory parts —folds, gills, or villi—in any form is 4,800, the number of villi in *Ophiogomphus*. Counting all the folds, we get only 240 for *Mesogomphus*. *Anax* has about 1,900 villi, and the other forms with villi a like number. The forms with folds never show over 300 folds.

A point of special interest in the case of *Mesogomphus* is that its gill-folds are apparently the most primitive form of gill found in dragon-flies. With this as a centre, we can proceed to all the forms of gill. One line, with slight change in form of buttress fold, leads to *Anax*, *via Aeshna*, and *Cordulegaster*. Independently there seem to have arisen at two points on this line of evolution villi. The villi of *Gomphus* and *Hagenius* are so different from those of *Anax* that we may safely consider them as morphologically dissimilar.* Another line, leading from *Mesogomphus*, leads directly to the Libellulidæ, by suppression of the longitudinal folds. When we consider that the experts on dragon-flies, such as Needham, Ris, etc., hold that the Gomphinæ are the starting-point for the evolution of the more specialised forms, we see this statement confirmed. The rectum of the nymph of *Mesogomphus* gives us the most primitive known form of that part as a respiratory organ.

(*Read July 7, 1917.*)

TRANSACTIONS OF SOCIETIES.

SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS.—Thursday, February 21st: Prof. J. H. Dobson, D.S.O., M.Sc., M.Eng., M.I.Mech.E., M.I.E.E., A.M.I.C.E., President, in the chair.—"*The Industrial Awakening of the war: South African development*" (Presidential address). Prof. J. H. **Dobson.** Attention was drawn, in the first part of the address, to the industrial research and investigation undertaken in Great Britain during the period since the outbreak of war, particularly in connection with the Fuel Research Board and the Coal Conservation Committee. The effect of war conditions on South Africa was then referred to, and the compensating advantages, resulting in improvement in internal trade and the birth of new industries within the Union, were pointed out. Allusion was made in particular to the country's coal resources, to certain possibilities of water power, and schemes of power supply and distribution, to the question of liquid fuel, to the problem of transport and the prospects of some base metal industries.

SOUTH AFRICAN INSTITUTION OF ENGINEERS.—Saturday, March 9th: G. M. Clark, M.A., M.I.C.E., President, in the chair.—"*A short note on types of induction motors*": J. W. **Kirkland.** The paper described briefly the leading features of various types of induction motors, and directed attention to their relative advantages and disadvantages.

* See Ris, 1913.

PROBLEMS IN TERRESTRIAL PHYSICS THAT REQUIRE THE ATTENTION OF SOUTH AFRICAN PHYSICISTS.

By Prof. John Todd Morrison, M.A., B.Sc., F.R.S.E., A.M.I.E.E.

There are several problems of world-wide interest in terrestrial physics for the investigation of which South Africa is specially well fitted by her geographical situation and climatic conditions. In regard to some of these it may even be said that no general solution is likely without the co-operation of scientific men in South Africa. The organization, or at least the encouragement, of such researches seems a matter which lies peculiarly within the province of this Association, and I have accordingly ventured to call attention to one or two of them.

1. The first question to which I should like to direct attention as specially suitable for research in South Africa is the determination of the intensity of solar radiation at the outer limits of the earth's atmosphere, the so-called "solar constant." This is probably the most important datum in meteorological physics. Its accurate determination is an essential for any reasoned discussion of the distribution of temperature, pressure and movement in the atmosphere. It has a profound bearing on solar and planetary physics, as well as on the study of the general conditions of life on the earth.

It has been the subject of investigation by many physicists in Europe and America, notably by Langley and his successors; but its value is still the subject of dispute, owing chiefly to differences in the estimates of the loss the radiant energy suffers in its passage through the atmosphere. The question has recently entered on a still more interesting phase, through the observations of Abbot, Fowle, and Ehrlich,* the Mount Wilson observers, who believe that they have shown the radiation itself to fluctuate considerably within the course even of a few weeks, quite independently of the state of the earth's atmosphere. This observation, if confirmed, would obviously be a discovery of great importance, alike in solar and in terrestrial physics. It can hardly be satisfactorily either upheld or disproved, except by a succession of observations made simultaneously at stations widely separated on the earth's suface, so that it may be determined whether the observed variations arise from local atmospheric changes not duly allowed for, or are world-wide in character.

For observations of solar radiation, a first requisite is the reduction of atmospheric absorption and scattering to the lowest possible point. For this purpose, the observing station (if there is only one) should be high, its climate should be dry, and it

* C. G. Abbot, *Physical Review*, Vol. VI, Ser. 2, pp. 504, 505.

should be situated near the tropics, so that the midday height of the sun should be as great as possible. In all these respects South Africa is well situated, and observations made on one of the highest peaks in the Drakensberg, simultaneously, if possible, with similar observations at other stations at lower levels, would be of the utmost value. The observations should, if possible, include determinations of total radiation and also of the intensities of special wave-lengths, selected to test the general absorption and scattering and also the selection absorption of the atmosphere.

2. The research just suggested involves another, which is important on its own account, namely, the quantity of radiant energy absorbed, scattered and radiated at various levels in the atmosphere. This continually varying influx and efflux of energy is the prime factor in determining the temperature and movements of the various layers. It is fairly clear that the lower turbulent layer, with its roughly adiabatic distribution of temperature, receives its heat mostly from the ground by conduction, convection, and reflection, while the upper, serener, isothermal layer has its temperature maintained by the daily influx and nightly efflux of radiant energy. But there is still much to be done ere any precise summary can be made of the relative proportions and absolute magnitudes of the different processes at work. There are indications, too, that the division of the atmosphere into two layers is not quite a full account of the whole phenomenon.

3. The third line of research which I wish to suggest is an extensive one, but it is also one in which it is high time that South Africa should play the part for which it is so obviously fitted—I mean, the investigation of the temperature, pressure, and movements of the atmosphere, and especially of the upper atmosphere, by modern methods, including captive kites and balloons and ballons-sondes fitted with measuring instruments. The two circumstances that make a special call on South African physicists in this matter are the comparative simplicity of the South African climate and its position near latitude 30° S. In dealing with phenomena so complex as those presented to us by the atmosphere, the advantages of simplicity are so obvious that the point need not be laboured. As regards the importance of latitude 30° S., that appears to arise essentially from the fact that that parallel divides the surface of the Southern Hemisphere into two equal areas, so that the parallel appears to be the main dividing line between trade winds and anti-trades as regards horizontal movement, and between the great upward equatorial and the great downward polar trend of the air. The yearly shift of the sun in the sky may be regarded, however, as roughly carrying the whole meteorological system with it, so that we in South Africa are well within the equatorial belt in summer and well within the polar belt in winter. We are thus in a position to explore both regions with facility, and are able, as it were, to draw a north and south vertical section through

two of the most interesting and characteristic parts of the atmosphere. Hitherto, so far as I am aware, nothing has been done in South Africa except the ordinary routine surface observations of rainfall, barometer, wind, wet and dry bulb thermometer, and the very valuable surface work of Mr. Sutton at Kimberley. I doubt whether we even know the ordinary cyclonic tracks in the lower atmosphere. There is therefore a very wide and open field for observation and discussion in this branch of meteorological physics, a field likely, when cultivated, to yield a rich harvest of important results.

4. The comparative simplicity of the South African climate suggests the possible fruitfulness, here if anywhere, of another line of research which has fascinated many investigators—I mean the enquiry into possible periodicities in atmospheric climatic conditions. Mr. D. C. Hutchins devoted a good deal of attention to the question of the periodicity of rainfall, and I have made some analyses, by Fourier's method, of the rainfall at the Royal Observatory, Capetown, of which I read a preliminary account before the South African Philosophical Society a good many years ago. . The results reached may perhaps be regarded as at least justifying the expenditure of some more labour, more especially as a good deal has lately been done to shorten the necessarily lengthy time needed to carry out the computations by the contrivance of harmonic analyzers and other counting devices. I have just had constructed a single working model of a harmonic analyzer on what I think is a new principle, and hope to attack the question of rainfall periodicity with its help.

5. There is one more field of geophysical research in which international co-operation is essential, and for which, I think, the evenness of our coast-lines gives us special natural facilities, namely, the investigation of ocean and earth tides. In regard to the former the observations of Forel have made us realize more fully than ever before that each ocean has its own particular type and amplitude of forced tidal oscillations. The calculation of the tides even in an isolated ocean of simple type has hitherto proved itself beyond the powers of our analysis; and it seems unlikely that we shall ever be able to account by mathematical methods for the tides in the actual oceans, with their intercommunications, although dynamical reasoning is of great importance in indicating the directions which observational work should follow. There is therefore room for much work on the classic lines laid down by Forel. For this purpose tide records would be needed at points well distributed along the coasts of the chief oceans. A tide-recording machine at Port Nolloth or Swakopmund would be helpful in the study of the tides of the Atlantic; one at Cape Agulhas, or other similarly placed point on the South Coast would be essential in the analysis of the tides of the Antarctic oceanic belt, while one well up the East Coast would help in regard to the Indian Ocean.

To turn to earth-tides, I should like personally to be able to repeat in South Africa the recent brilliantly conceived and

executed measurements of Michelson* on the tidal oscillations of a pair of short underground horizontal canals. These measurements seem, of all hitherto made, to be most likely to lead to a trustworthy determination of earth-tides, and of earth rigidity; but it is essential that they should be repeated at various places and under a variety of local circumstances. As is well known, the total effect observed arises from about six different though connected causes which have to be disentangled, and it is highly desirable that the measurements should be made at places well removed from the coast, so as to give the earth-tide as much relative prominence as possible. Geological simplicity of underground stratification is also desirable. Both of these conditions can, I imagine, be tolerably well fulfilled towards the central parts of the Union. Unfortunately, the method is expensive in respect both of time and money. On the other hand, in regard to the mathematical and astronomical collaboration that would be necessary, we might, I think, confidently rely on the practical sympathy of one of our members, the Astronomer Royal, universally recognized as the greatest living authority on the subject.

The programme of research I have taken leave to suggest may appear at once too ambitious and too partial. As regards the latter condition, I have simply noted a few things in which I happen to be personally interested. As regards the former, I believe that well-considered organization of our available workers, inside and outside of the universities, on lines mutually agreed on, would enable us to attain results of no small importance. I cannot think of any better method of setting such an organization on foot than through the formation of a Meteorological and Geophysical Committee of this section, for the direct business of organization of research. Such a committee would meet annually at the meeting of this Association, to consider the progress of the previous year, map out future work, get in touch with fresh workers, and endeavour to secure the necessary financial help from the State and from private benefactors.

If the suggestion should prove fruitful in regard to the particular researches I have taken leave to note as desirable, it might readily be extended to the work of other sections. Only, I think it would be well that the available scientific strength of any one section should not be dissipated on too many subjects at the same time.

(*Read July* 4, 1917.)

DISCUSSION.

Mr. J. S. VAN DER LINGEN: As a former pupil of Prof. Morrison's, I gladly pay a tribute to the inspiration which he gave to his classes. It was at his instigation that I started certain work connected with the colour of the sky and allied

* A. A. Michelson, "Rigidity of Earth," *Journal of Geology*, **22** [2], 97-130.

phenomena. As early as 1909 a theory of the origin of the colour of the sky was advanced, and according to it, selective reflection must take place in the upper atmosphere, the spectra of the reflected light having a maximum intensity in the neighbourhood of H.

Nicholson has actually observed an emission line under certain conditions. Our observations up to the present have not yet confirmed this result.

Prof. A. BROWN: The thanks of the Section and of the Association are due to Prof. Morrison for his interesting and timely paper. He did well to point out the peculiar suitability of South Africa for work on solar radiation. A point of practical importance in this connection is that the work could naturally be co-ordinated with the problem of obtaining power direct from the sun's radiant energy. Only a qualified success has attended efforts in other countries, and the problem is regarded rather as one for the future, when the inaccessibility of fuel reserves may make the use of sun-power a sounder economic proposition. It is a matter for investigation whether even now this source of power might not be profitably tapped in parts of Africa, where fuel is not easily available and sunlight is intense and continuous.*

Meteorology is always with us; and so far the practical results of the science have been disappointing. The farmer still asks in vain for a reasonable forecast of the date of beginning and the time-distribution of the seasonal rains. A difference of three weeks in the date of commencement may ruin a crop—*e.g.*, of mealies—whereas a rough previous knowledge of the date would enable the farmer to adjust his time of sowing so as to get the full benefit of rain available. There are striking local differences of distribution in areas nearly contiguous, and the collection and examination of data for a limited district might lead to practical conclusions.

The questions of evaporation and percolation as leading to loss of impounded water are already receiving attention.†

The field of geophysics suggests wide possibilities. The work of Sutton should be mentioned in connection with small motions of the earth's crust. Some work also has been done on earthquakes, and in certain places in South Africa seismological records are available. Some interesting questions arise out of Prof. A. Young's investigations into tidal phenomena in underground water.‡ A possible explanation is the yielding of the earth's crust under the pressure of ocean tides, accompanied by the squeezing out of underground water where it has access to

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* Ingham, Presidential Address. *Proc. S.A. Inst. of Engineers*, Aug., 1915.

† A. D. Lewis: "Run off and Reservoir losses at Van Wyk's Vlei."—*Proc. S.A. Soc. C.E.* (1915), 5. A. H. Hallis: "Railway water supplies, with special reference to Vryburg-Bulawayo Section." *Proc. S.A. Soc. C.E.*, (1916), 206.

‡ *Trans. R.S. S. Africa*, (1913), 3 [1] 61.

the air. This gives a point of contact with Michelson's work referred to by Prof. Morrison, and offers an encouraging field for South African investigation.

The whole question of underground water is of special importance. In Australia this has been realized, where it has been the subject of many reports, and is still under investigation. In tracing the source of water, the temperature at emergence may furnish a clue; and this leads to problems in the passage of heat along these water channels.

The determination of the heat conductivity of the various rocks should be carried out systematically, and the temperature gradient downwards found for different places. There are obvious practical issues in connection with the cooling of deep-level mines in addition to the scientific importance of having geophysical constants collated for different parts of the earth.

Of rather a different kind is the problem of the motion of sand on land. Practical engineers have dealt with this question from time to time, in order to prevent the devastation of special districts. Elsewhere observations have been made on the rate and mode of travel of sand-dunes. On the ripple formation in sand a good deal of descriptive work has been done, and recently the importance of the subject in connection with palæontology has given a further stimulus in this direction.*

(*Received November 5th, 1917*).

Curvilinear Space.—Dr. de Sitter, of Groningen, in a paper on "Einstein's Theory of Gravitation," has drawn attention to some curious consequences of the assumption of curvilinear space. One of these is the theoretical existence of a point where the ordinary conception of three dimensions in space and one in time is reduced to space only, with no time at all. This can only refer to an epoch before the beginning or after the end of eternity. Another—somewhat paradoxical—result, is that for a suitable value of the curvature of space, light from the back of the sun should be faintly visible at the opposite point of the sky.

* E. M. Kindle: "Recent and Fossil Ripple Marks."—Canada, Dept. of Mines, Geological Survey, Museum Bulletin, No. 25.

PLANT TOXINS, A CAUSE OF INFERTILITY IN SOILS: A SOUTH AFRICAN OBSERVATION.

By ARTHUR STEAD, B.Sc., F.C.S.

(*Plate* 13.)

The husbandman has ever been persistent in his belief that a crop may poison the land for itself, so that when the same crop is grown year after year on the same land the yields will become gradually less, and finally dwindle to nothing.

He has always believed in the rotation of crops, by which he imagined decline in yields was prevented because the one crop was not only not injured by the poisons of the other, but actually had some power to destroy the poisons of the other.

Ideas of this kind were crystallized by De Candolle in an hypothesis enunciated at the beginning of last century and favourably commented on by Liebig, who wrote, about 1840:

> De Candolle supposes that the roots of plants imbibe soluble matter of every kind from the soil, and thus necessarily absorb a number of substances which are not adapted to the purposes of nutrition, and must subsequently be expelled by the roots and returned to the soil as excrements. Now as excrements cannot be assimilated by the plant which ejected them, the more of these matters which the soil contains, the more unfertile must it be for plants of the same species. These excrementitious matters may, however, still be capable of assimilation by another kind of plant which would thus remove them from the soil and render it again fertile for the first. And if the plants last grown also expel substances from their roots which can be appropriated as food by the former, they will improve the soil in two ways."

Certainly De Candolle's hypothesis must, in the light of his time, be considered as an ingenious and plausible attempt at explaining certain well-known facts connected with the rotation of crops. For instance, in England clover cannot be grown two years in succession, while it leads to a considerable improvement in the following wheat crop. Further, how may one explain the fact that certain plants grow better in association than apart?

G. C. Daubeny* investigated De Candolle's hypothesis by growing 18 different crops under conditions of rotation as well as otherwise. He obtained declining yields in all cases, while there were many cases where the crops were grown in rotation in which the decline in yields was not so marked.

De Candolle and Daubeny were ignorant of the effect of tillage operations in increasing the output of the soil in plant food and in conserving rainfall in the soil; neither did they know that the benefit of clover to wheat consisted in the former adding nitrogen to the soil which, in England, is the dominant food for the wheat crop; nor did they appear to know that by growing crops in rotation weeds, insect pests and diseases were kept under better control.

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* *Phil. Trans.* (1845).

All the more were these things unknown and unsuspected by the early farmer, as, indeed, they are unsuspected by the more simple of our own farmers to-day, which the following will serve to illustrate. At a lecture at Witkop (Stormberg) the writer was asked what "kracht" (virtue) the potato crop put into the ground, it being common experience in the district that the wheat crop which followed potatoes was very much better than the wheat crop which followed wheat or other cereal. The confident reply was that the "kracht" consisted in plenty of hard work, a view that was readily accepted by the meeting, because, said they, "we plough only once for wheat, but many times for the potato, which, moreover, is kept free from weeds all through the season by periodic scofflings. If this were not done, we should get no potatoes."

With increasing knowledge theories such as De Candolle's gave way to the view that, provided all other conditions are satisfactory (viz., air and moisture supply, root room, temperature, etc.), the yield of crops is determined by the plant-food supply.

This view appears to have been universally held until rather more than a dozen years ago, when Witney and Cameron, of the American Bureau of Soils, startled the world by reviving De Candolle's hypothesis. They gave it out that the infertility of soils could not be due to a lack of plant-food, because the soil-water (on which plants feed) contained the same amount of plant-food, whether the soil be a rich or a poor one. They stated, moreover, that while the water extracts of good soils were suitable, water culture solutions of poor soils were not, and, furthermore, that these latter proved better culture media in proportion as they were diluted with distilled water. On such considerations they argued that the infertility of soils must be due to the presence of toxins, and not to any shortage of food. Thus, in Farmer's Bulletin 257, Whitney stated:—

There is another way in which the fertility of the soil can be maintained, viz., by arranging a system of rotation and growing each year a crop that is not injured by the excreta of the preceding crop; then, when the time comes round for the first crop to be planted again, the soil has had ample time to dispose of the sewage resulting from the growth of the plant two or three years before.

The resemblance to De Candolle's hypothesis is very obvious.

Again:

I should say that the soil ought to take care of the excrement of plants. Whether it does this through the agency of bacteria, whether it is due to the abnormal absorptive power of the soil or to direct oxidation, we do not know. *Take a natural soil, a prairie sod; the sanitary conditions in that soil are almost perfect.* (The italicising is the writer's.)

Further:

Apparently these small amounts of fertilizers which we add to the soil have their effect upon these toxic substances and render the soil sweet and more healthful for growing plants. We believe that it is through this means that our fertilizers act rather than through the supplying of plant-food to the plant.

A. Stead.- Plant Toxins.

The writer could proceed to deal with the vast amount of evidence put forward by Hopkins, King, Hall, Hilgard and Russell to rebut this theory of Whitney and Cameron's; but since his intention was to only outline the theory so that the bearing of what is presently to follow will be apparent, the reader is simply referred to the writings of those authorities.

To come to the observation which it is desired to place on record, the writer was, some time ago, engaged in soil survey work on the farm Zuurmelkfontein, in the Elliot District, when he came across a virgin land that had refused to give a crop of oats the first year it was under cultivation, and maize the second year, except where it was manured. The soil was an acid, grey sandy loam, and of a type that is known throughout the district for its poverty. Similar soils usually give out after about three years' cropping, but they respond well to phosphatic manuring whether applied as superphosphate, basic slag or bone meal.

Knowing the soil to be poor, the farmer sowed it, in the first instance, to oats. As has already been stated, no crop was reaped.

The farmer then thought he would experiment. He accordingly planted the land the next year with maize in three ways, *i.e.*, without any manure, with lime, and with bonemeal. Unfortunately the farmer kept no records of quantities; but the amounts of fertilizer applied would probably be about 300 lbs. per acre of lime and 200 to 250 lbs. of rather coarse bonemeal per acre.

Where nothing was applied, the crop was an absolute failure; likewise where lime was applied. In both cases the plants grew to an average height of about 18 inches. Here and there a plant tried to produce a cob; but none of them bore any grain.

Where, however, bonemeal was applied the plants grew to an average of 5 feet in height, and bore rather small cobs, which were well covered with grain. It should be stated that both lime and bonemeal were applied through the planter.

The failure of the lime to effect any improvement whatever would seem to show that the acidity of the soil was not the principal limiting factor; while the action of the bonemeal, taken in conjunction with the experience of the district that any kind of phosphate would give increased yields on this type of soil, would make it appear tolerably certain that the bonemeal acted through its phosphoric acid, and not through its nitrogen. The analysis of this soil showed that it was deficient in nothing except carbonate of calcium and phosphoric oxide. Of the former it contained a mere trace, of the latter 0.035 per cent. only, which also furnishes further evidence that the bonemeal acted through furnishing phosphorus as a plant-food.

Attached hereto is a photograph (Plate 10) which the writer took of a portion of the field when the crop was ripe but untouched. On the left-hand side, where the man is standing,

lime was sown. It will be noticed that there is no crop worth speaking about.

To the right of the man there is a single drill of much better growth, then one of stunted growth, and then a block showing fair growth. These were the mealies which received bonemeal. The stunted row, however, received no bonemeal owing, the farmer explained, to the fact that the fertilizer attachment of the planter had become choked. Throughout the good patch there were other stunted rows due to the same cause. These, while testifying to the uniformity of the soil, afforded an excellent, although accidental, series of controls.

It would be interesting to learn whether any cases similar to this have been noted elsewhere. Anyhow, this solitary case would seem to afford an illustration of the untenableness of Whitney and Cameron's toxin theory.

(*Read, July 6, 1917.*)

Hay Fever.—The *Medical Journal of South Africa* remarks that a short time ago correspondence appeared in the press tending to incriminate the pepper tree (*Schinus molle*) as being the cause of hay fever. It has been asserted that hay fever can be caused only by the pollen of those plants which depend upon the wind for its distribution. In other countries the hay fever of early summer is associated with the flowering of the grasses, and of late summer mainly with the flowering of certain of the Compositæ. It seems possible that the pollen of *Cosmos* and of the maize plant may be effective in South Africa, but in the United States of America, where the subject has been extensively investigated, the only tree implicated has been the cotton wood.

Light-absorbing Matter in Space.—About eighteen months ago Barnard discovered about the star Nova Persei a nebulosity of fan-shaped appearance. More recent photographs show, in addition, a sharply-defined continuous ring of nebulosity, of which the central point is the nova. Great expanding rings were photographed around this new star at its original outburst in 1901, and W. W. Campbell, of Lick Observatory, in his presidential address to the American Association for the Advancement of Science, explained the phenomena of temporary stars by the theory that a dark star, travelling rapidly through space, has met with resistance, such as a great nebula or cloud of particles. The rushing of the dark star into and through this resisting medium would cause a great wave of light to go out from the moving body, and this, falling on non-luminous materials, would make a ring of nebulosity, visible by reflection. From the above and other facts Campbell infers the existence of a stupendous amount of obstructing material scattered throughout our stellar system.

NOTES ON FIBRE PRODUCED FROM SOME OF THE MOST USEFUL INDIGENOUS AND EXOTIC PLANTS IN THE CAPE PROVINCE.

By James Leighton, F.R.H.S.

Present conditions are causing a great scarcity of all kinds of cordage, and my object in this paper is to direct attention to the vast wealth of raw material at hand awaiting development, and capable of at least supplying our own needs.

Many of these fibres may be prepared by rating in the same way as flax, and with a little training, natives would soon become expert at this work. There is an abundance of fibre-producing plants, obtainable at many places throughout the country, while flax, hemp, *Agave*, *Fourcroya*, *Phormium*, and other plants may be cultivated.

I shall first deal with some of our indigenous plants.

Cyperus textilis, produces a strong, useful fibre capable of being made into ropes and strong cord. It is commonly found near the margins of rivers and in wet places, where it grows to a height of about six feet.

Cyperus hexangulare is another valuable rush, thriving in less moist places than the former.

Sansevieria thyrsiflora, a liliaceous plant, allied to *Phormium*, is a stemless perennial plant with thick fibrous leaves, sword-shaped, and sheathed at base. This plant is common in the shade of bushes and dry places throughout the Eastern Province. *S. Guiniensis* produces the bowstring hemp. The fibre of our species is of a very fine quality, capable of being made into string and thread. This plant may prove worthy of cultivation.

Fleurya peduncularis, a nettle, common in the Buffalo Valley, producing strong procumbent stems 8 to 12 feet in length, yields a good fibre, somewhat like *Urtica nivea*, the China grass. *Malvestrum capense*, a tall malvaceous shrub common on the margin of cultivated lands, has a very strong fibrous bark.

I shall now deal with some of the exotics that have become acclimatized. *Agave Americana* and its variegated form is well established, and in many cases it has grown into dense masses. It is a hardy species thriving in dry places, where few other plants could exist. The fibre is strong, and suitable for the manufacture of ropes. The fibre is best obtained by passing the thick, succulent leaves through heavy rollers. The pulp thus extracted may be mixed with meal or dry hay, and used for feeding stock. Mixed with ley ash, it is used in the manufacture of soap capable of lathering in salt water as well as in fresh.

Phormium tenax, New Zealand flax, a genus of Liliaceæ with one variable species, confined to New Zealand and Norfolk Island, is a tufted plant with sword-shaped leaves growing in opposite rows and clasping each other at the base. Given good

ground and plenty of moisture the leaves may be grown to a length of 8 or 10 feet, but its usual length is from 4 to 6 feet. It is used by the natives of New Zealand for making a coarse, rough clothing, as well as string, mats, etc. The presence of a viscid, gummy matter in the leaves has hitherto rendered the cost of preparation too greet, but that difficulty has now been overcome, and the future of this plant seems to be promising. Without manipulation narrow stripes of the leaves may be used in the garden to replace string. Irrigation would be required for its successful cultivation.

Now that Manilla hemp cannot be imported, an effort should be made to replace it with the fibre of the plantain *Musa paradisiaca,* a closely allied species of *Musa textilis.* This is capable of producing a hemp not inferior to that plant. The plantain is more hardy than the banana, grows much taller, and can be grown even where a few degrees of frost is experienced. Plants mature in three years, when the fruit may be harvested and the rolled-up leaf-stems removed and treated for its fibre.

Young plants are produced annually from the underground stems, so that an annual supply of mature plants are maintained without replanting.

I am convinced that a hemp can be prepared from this plant to take the place of Manilla, which has hitherto been almost the only fibre that can be used in the self-binding reaper. All available plants ought to be turned to account. This is only an imperfectly prepared sample, but it will suffice to show its length of fibre and strength.

Mauritius hemp, *Fourcroya gigantea,* is used in the Mauritius and elsewhere: like Sisal hemp, the large fleshy leaves are cut after the third year, rotted in water and beaten out. This plant is not so hardy as the American aloe, but it will grow well without irrigation, producing leaves 10 feet in length that will yield an abundance of useful fibre.

Sterculia diversifolia, an Australian tree, usually planted for ornament, has a thick bark containing a large quantity of very strong fibre of commercial value. It is a quick-growing tree, and can be easily propagated from seed or cuttings, growing freely from large limbs like the wild fig, and when cut down a young growth springs up rapidly from the old stumps.

The inner bark of the young trees is easily removed in ribbon-like strips, and may be used as a bast, but the whole of the bark in the older trees contains good fibre. Several Indian species yield a cordage, and *Sterculia tragacantha,* of Sierra Leone, yields the gum of that name.

There are many other good fibre-producing plants that I have not mentioned, but those dealt with will suffice to show the wonderful possibilities that lie in this direction, providing material for the establishment of an industry capable of employing a large amount of labour, and supplying our own needs as well as exporting a large surplus.

(*Read, July* 5, 1917.)

THE MOVEMENT TOWARDS A NATIONAL SYSTEM OF TECHNICAL EDUCATION.

By William James Horne, A.M.I.C.E., A.M.I.E.E.

A system of technical education for South Africa should be considered in relation to five outstanding features peculiar to this country:—(*i*) The proximity of an overwhelming native population; (*ii*) the existence of large and industrious coloured communities; (*iii*) the fact that the bulk of the white population are non-industrial from a manufacturing and a mining point of view, being, in the rural areas, mainly breeders of sheep and of transport cattle with a limited agriculture; and, in the urban areas, largely importers and store-keeping merchants; (*iv*) the existence of a large and growing poor white group, composed, for its greater part, of the descendants of the original pasture-farm holders; and (*v*) that there is observable in the youth of this country an early adolescence coupled with a lesser educational attainment at a higher age as compared with the youth of Europe.

The presence of the native provides a kind of perpetual boy, or juvenile, of adult physique who, by his numbers and physical strength, occupies those openings in industry through which the white youth would enter as a learner. Another effect of native labour is that it has set up what has been called the "kaffir standard"; one result of this being that the South African in charge of a group of native workers is, unless he has been under European standards, limited at his best to the best which, in his experience, natives are capable of doing: this result is reflected in the reports of the High Commissioner in our exports in fruit and meat to the London market. Another result is an unwitting self-sufficiency on the part of the South African overseer; we have had to be content with the native standard of efficient performance as sufficient, until we have come to the false conclusion that what is good enough for us, the masters in this country, should be good enough for the inhabitants in any other.

The fact that the great bulk of the people are non-industrial as a type is traceable, but is not wholly due, to a ready and inexhaustible reserve of native labour of a certain low standard of efficiency. Industrialism, whether it be rural or urban in nature, demands a mode of life greatly differing from that experienced by a people whose forebears merely administered a pasture stock-farm, orchards, or vineyards with a plentiful supply of coloured labour; the change involved is that from the freedom of an overseer of semi-*un*skilled labour to that of a directed skilled worker continuously applying himself between definite hours for the greater and best part of the day. Such regulation of action as this new industrialism demands for its efficient performance, implies a large amount of restriction upon

the personal freedom of the erstwhile trekker and hunter. Changes such as these in a people can be brought about only gradually and under the stress of circumstances of a competitive nature, but these changes can be hastened by a system of technical education which does not demand too long a scholastic leap from the younger people. It is largely because these changes in the people are not keeping pace with the increasing competition to live in this country that we have the poor-white problem.

Our industries such as we have are manned, at any rate when skilled dexterity and knowledge based upon length of experience are required, by overseas men to a very great extent. Certain of our industries are staffed, in the lesser skilled ranks at least, by coloured men. It is evident all over South Africa that the coloured people are not content with the kind of labour usually performed by the aboriginal native, and that they have worked their way to the rank of skilled artisan; in this sphere thousands of them find constant employment at considerably high rates of pay. Very few of them, however, can be classed as thorough and reliable tradesmen; their methods are slipshod, and their knowledge of the craft they have come to practise is limited. Nevertheless, they are gradually becoming more proficient, and they are entering seriously into competition with the white artisan, who usually retires from the field in the face of the low wage for which these coloured people, with their cheaper methods of living, are prepared to work. Of recent years there has been a marked influx of coloured people to the more northern towns of the Union, and particularly of the Transvaal, due, undoubtedly, to an increasing demand for cheaper labour in manufacturing industries recently established. The industries in which the coloured man has obtained a considerable footing are: the leather-working trades, in which it is usual to find one white foreman with a dozen or so coloured assistants as stitchers, snickers, etc.; in the furniture-making business, in which they are usually engaged to assemble American imported goods, and in box-making—they speedily learn the use of tools, and there is now more than one furniture factory in South Africa in which the employés are all coloured people; in soap-boiling and in sugar-refining the Eurafrican and the Asiatic find ready employment; in the printing trade, too, the coloured element is well established; in the building trade, in the more southern half of the Union the coloured carpenter, the coloured painter, and the Malay plasterer with his coloured learners are all well known—it is but a matter of time when they take their places in the Transvaal; their scouts are there already. The openings, therefore, for our own white youth would appear few even if he were suitable; he has, however, the advantage of being on the spot, and the thing to do is to train him for that skilled employment which alone is suited to the white man as overlord of this country. Actually the openings for white youths are more numerous than they seem, and

much more numerous, owing to the present war, than they have hitherto been.

The training required must raise the white worker above the limitations of the coloured; it must produce in him the initiative to advance beyond the standard practice of his predecessors, to do more intricate work in his trade and to do it well, to devise new methods and new tools—in other words, to break new ground. It is in these finer things that the bulk of the coloured people usually fail, they are good imitators but poor originators. A system of technical education to effect this must do more than merely instruct in methods that have obtained in the past; it must use these methods to educate to improvement in present methods with tuition in the latest advancements taking place in other countries. Many highly placed educationists think and say that there must be a complete system of primary school education, of which every child of school-going age is taking advantage, before consideration can be given to technical education; others would limit technical education to those who have completed the full primary school course or to those who can acquire a so-called preliminary technical certificate the subjects for which are not technical,* and require a preparation equal to that given in Form II. or Form III. of a Transvaal High School. Both attitudes appear to me to be based upon a mistaken idea of the value of uniformity—that children must all learn the same things in the same way however much their intelligence may differ one from the other—that it is their duty to climb what is called the educational ladder by the rungs, and that they may not "shin" up the sides of that ladder. Neither attitude appears to recognise that a system of technical education beginning with tools and materials in the workshop will lead to the acquirement of a general education on the part of the pupil, together with a desire for more knowledge of the theoretics of the craft. Each would appear to condemn the intelligence because it cannot acquire a certain standard in theoretical subjects of which it cannot see the practical application, of which it cannot "see the use." Because there is an early adolescence coupled with a retarded general education, compared with European standards, appears to me to be one of the very reasons why a special system of technical education is necessary for this country.

The five retardations—the native population, the coloured community, the absence of industrialism in previous times, the poor-white problem, and the early adolescence with a lower average standard of general education—show that a system of technical education to be suitable for the bulk of the young people in this country must depart largely from any European

* The subjects of examination for the Preliminary Technical Certificate of the National Advisory Board for Technical Education, Union of South Africa, are:—(i) civics, (ii) one of the official languages, (iii) mathematics, (iv) technical drawing, and (v) experimental science or manual training, with the recommendation that experimental science be taken in place of manual training.

system in which the same or similar conditions have not obtained. The system for this country is that which begins in the workshop with trade practice in tools and materials, together with some education at the classroom desk in drawing, theoretics, and the subjects of a general education—all closely related to industry and suited to the advancement of the pupil. Evidence is not wanting of the insufficiency of the system which places desk instruction in theoretics in the forefront with some practical workshop instruction, explicit or assumed, in the nebulous background. Here is what the sub-committee of engineers, appointed by the Transvaal Chamber of Mines to consider the training of apprentices, have to say:—

> Technical education during apprenticeship . . . No fixed curriculum for class work to be set, but each boy to be treated according to his requirements and capacity for absorbing knowledge. The classes to be made more attractive and more suitable for the trades the apprentices are learning. . . . The principal point we wish to emphasize is that, in our opinion, the afternoon and evening classes are conducted on a scale which is generally far above the intelligent appreciation of the apprentice. We would prefer to see a different series of lectures arranged for the apprentice more applicable to his general training.
>
> In our opinion much more good would be done by appealing to a boy's intelligence through his eyes rather than through his ears, and to drum into a boy higher mathematics and the theory of heat, and similar subjects, is only to make him tired to death of the continuation classes. If he takes no interest in them it is no use holding them, and we would propose . . . laying out a more attractive scheme of . . . class work.

It is not only in this country that complaint is made of the classroom instruction in technical theoretics; thus the Manchester Engineers' Club, when considering the best means of organizing the British engineering industry, formulated this resolution, among others:—

> That the instruction of apprentices in part-time classes be reformed, so as to relate it more closely to the apprentices' every-day work.

Similar quotations could be given from the Annual Report for 1915 of the Department of Agriculture and Technical Instruction in Ireland. What these extracts indicate is that technical instruction at the desk is useless for its purpose when divorced from the practice in the industry to which it relates; once it has become abstract it is "above the heads" of the apprentices. The system of technical education which will correct this is that in which the practice of the industry comes first and the discussion, calculation and deduction of the underlying principles comes second. For this to be possible there must be the closest correlation between the practical or workshop instruction in the industry and the classroom instruction in theoretical subjects. It is impossible to correlate the work of an apprentice in the commercial business with the theoretical instruction; it is also impossible to retard the instruction in theoretics to suit the nature and amount of the commercial output in the business. It is in the first two or three years of the apprenticeship that these difficulties of correlation occur; later, there is little difficulty in suiting the instruction in theoretics to

the requirements of the industry, provided the pupil is commercially employed where the whole practice of the industry is experienced. Therefore, for the first two or three years, a trade workshop at the school is essential. The accepted name of the institution that embodies these principles is the "Specialized Trade School"; when more than one trade workshop is included, we have the "trades school"—the type that has been established in the Transvaal. These should be carefully distinguished from the type known as the "junior technical school," in which desk studies predominate and the workshop is a merely minor incident in the curriculum and of the manual training kind.

There is another type of vocational school, the industrial school; one or two of them are penal, the majority of them are not. They are the preventatives against the expansion of the poor white problem. They have been defined "as intended to develop a general handiness"; this is one of these easy-going expressions that may mean just what you will; South Africa has had too many of these phrases, which may mean anything or nothing, and it is time to know where we stand, in technical education at any rate. As a matter of fact, these schools teach trades, and do not teach them badly as far as the teaching goes, They are, however, not sufficiently modern; the extent of the trade teaching is too limited, and is not sufficiently intensive. They have to increase an inadequate grant, by contracting for and competing in the open market; this is educationally unsound. Father Tozzi, the head of the Salesian School in Capetown, puts it well when he says:

> We must remember that a trades school is not a shop. In other words, it is the pupil who is being considered all through, and not the market value of his work at any given moment, as is apt to be the case in regard to apprentices in ordinary workshops. As an example, the boys in an industrial institution who are learning tailoring sometimes make suits for the inmates, although the great bulk of the clothing is bought ready-made because it is cheaper to do so; but they are not called upon to do the patching for the institution, which they might be, if economy, and not their own skill and future prospects, were the main consideration.

The point I want to emphasize ends at the second sentence; the rest of the quotation illustrates another common and mistaken attitude towards industrial schools. These schools must be adequately financed and under efficient inspection, raised to modern sufficiency if for no other reason than that there are similar institutions dotted about the country, giving similar instruction to the native and the half-caste, such as the Native Mission in Tigerkloof, the Trappist Monastery in Natal, where trades are taught irrespective of colour, and the technical school for half-castes in the Province of Mozambique. Another type of industrial school much required is the school farm. The only one I know of is the Weston School of Agriculture at Mooi River, Natal. That, however, is a fee-paying school for the sons of farmers. It is significant that no one would suggest teaching agriculture without a farm, yet it has been proposed to

give technical instruction related to trades without adequately equipped workshops. In the country districts we require central dairying, field cultivation, and orchard schools—not class-rooms, but actual farm buildings and fields—with permanent or travelling skilled instructors according to the number and density of the population.

For girls, we need the domestic science or housecraft school, since employment in factories, as in Europe, is impossible for them owing to the presence of the half-caste, the Levantine, and the Asiatic female. Here again the school house is the workshop: you would not tell a girl how cooking might be done for invalids without making her cook; neither would you describe to her how a garment might be cut out and assembled without seeing that she cuts out and stitches real stuff. The commercial schools for both sexes are firmly established, chiefly because the commercial community know more definitely what they want than is usual with most other industrial communities; also they are prepared to state their requirements in syllabus form. The Associations of Chambers of Commerce of South Africa established a series of commercial certificates examinations reduced from those of the London Chamber of Commerce both in numbers of subjects and scope of syllabus, a sufficiently startling commentary on the standard of educational attainment in this country. Here also is the schoolhouse the workshop; you teach typewriting with real machines, not toys; the nearer your books in the book-keeping class approach the tools of the counting-house, the more efficient is the instruction.

I have mentioned these types of vocational schools to show that they all require and use the "workshop" as an essential part of the instruction, on the principle that *in breaking new educational ground, the practical work should come first, and the discussion, calculation and deduction of underlying principles should come second.* It is the trades school, and not the junior technical school, which applies this principle in teaching the future worker in the constructive trades. If we are to treat our own tin, iron, manganese and antimony ores instead of shipping them to Europe, it is the ex-trades school pupil who will build the furnaces and make them work; and this will be because he has been taught to build furnaces, to use them, and to handle the raw material in bulk, instead of being talked to from a highly coloured diagram and being shown small quantities of the raw material and its products in a chemical laboratory. There may be some who object to trades schools on the ground that the only fit and proper place for a boy to begin to learn his trade is in a commercial workshop. If that is so, why are there specialized trade day schools in London, such as the Stanley School of Engineering Trades, the Brixton School of Building, the Bolt Court School of Photo-Process Work and Engraving? Why are apprentices not taken in the gunsmith trade in Birmingham, and why are boys required to learn their trade on three afternoons a week in the Gunsmiths' School

under the joint control of the Association of Master Gun-makers, the Gun Workers' Union, and the Guardians of the Proof House? Why are there completely equipped workshops for the instruction of apprentices in the brass and iron-working trades in Manchester? Why did the Merchant Company of Edinburgh move the School Board of that town to the erection and equipment of workshops for the instruction of apprentices in the trades related to engineering, the tailoring trade, and printing? And why did they propose to put in force the clauses of the Compulsory Education (Scotland) Act of 1908, enabling them to limit juvenile employment to the forenoons, so that apprentices might attend for trade instruction in the afternoons? Why were the Wilmerding School of Industrial Arts and the Lick School of Machinery Trades established in 1894, in San Francisco, "to teach boys trades fitting them to make a living with their hands, with little study and plenty of work?" Why was the New York Trade School founded by Colonel Auchmuty in 1881 under the guidance of all the trades unions in that city? What caused Holland to establish trades schools in 1857, and why has she forty-four of these institutions to-day, in *addition* to the usual junior and senior technical schools and evening classes? What caused Prussia to follow suit in 1874, and to make them compulsory schools for all apprentices? Why was Kerschensteiner empowered to establish trades schools all over South Germany? Why have Austria, France, Switzerland and Sweden done the same? Why did the Canadian Commission on Technical Education recommend a German system of trades schools and not the English system of technical classes? Why have Australia and New Zealand established day and evening trades classes as distinct from technical theory classes? The answer will be found in a recent number of *Engineering*, in which the unscientific and haphazard method of training apprentices in many large industrial works of all kinds was roundly condemned. That refers to Great Britain; for the mine workshops on the Rand, the following from the report of the sub-committee of Engineers appointed by the Transvaal Chamber of Mines on training apprentices:

> There was usually no attempt to give a regular course of training in the shops, with the result that most of the apprentices only carried on a sort of "skilled labour" work thus becoming an evil, not only to the employer, but to themselves; . . . incompletely trained apprentices, when out of their time, could not compete with the best of the skilled tradesmen whose training had been of a superior kind. . . The apprentices do not appreciate the true meaning of discipline, and, in many cases, they are looked upon as a sort of necessary evil . . . an entirely wrong standpoint to take in view of the fact that the apprentice of to-day becomes the tradesman of to-morrow. . . . The attendance of evening classes was looked on rather as a duty by the apprentice, with very little appreciation of the good he would obtain from such training.

The result is that the Chamber of Mines has decided to give preference on all mines in future to trades school pupils by means of a shortened apprenticeship, coupled with increased wages; this decision being arrived at after an exhaustive enquiry by the subcommittee, in which they pointed out that two years at the trades

school was of great advantage both to the employer and to the boy.

One fear expressed in connection with trades schools is the over-production of skilled workers. I partially dealt with that point in a previous paper.* Mr. Beveridge, in his book on "Unemployment," shows that difficulty is largely due to want of fluidity in groups of workers, and was overcome in Germany by their system of labour exchanges, which he was afterwards appointed to organize in England. It is conceivable that this fluidity will be artificially increased after the war by the enemy Central Powers; the possibility is established by the organization of the International Workers of the World. It behoves us to see that our young men receive a skilled training fitting them for immediate and continuous employment, so that there may be as few openings as possible in the future for foreigners of enemy origin.

I submit that the trades school system of technical education, which starts in the trade workshop and leads to the class-room and the laboratory, is THE system required in this country; that it is superior to the system of the so-called junior technical school, with its technical instruction at the desk, which can end only in a desire for office work and a disinclination for that skilled manual labour necessary to the development of our resources by ourselves.

(*Read, July* 6, 1917).

SOUTH AFRICAN MUSEUM In the Report of the South African Museum for the year 1917, several additions to the exhibits of Karroo reptiles are noted. One of these is a partial skeleton in a slab of a new species of Dinosaur, and another is the skull of a large undescribed Dinocephalian allied to *Titanosuchus*. Other additions are an almost complete skeleton of *Prolystrosaurus natalensis*, a skull and lower jaw of *Dicynodon whaitsi*, the carpus of a species of *Pareisaurus*, a skull and lower jaw of a species of *Embrithosaurus*, and skulls of *Pareiasaurus bombidens*, and of a species of *Struthiocephalus*. A skull of *Glanosuchus macrops*, and the cast of a skull of *Lycosaurus* have been mounted.

Proofs of the co-existence in South Africa of man with extinct animals in the shape of stone implements, found together with remains of the now extinct animals and others which he slew for food are now exhibited together with vouchers showing evidence of still greater antiquity.

Three panels of Bushman paintings have been added, as well as several paintings on single stones, obtained in the rock shelters of the littoral, and executed by Strand-loopers.

* "Practical Education." *Rept. S.A. for Adv. of Sc.*, Pretoria, (1915), 604.

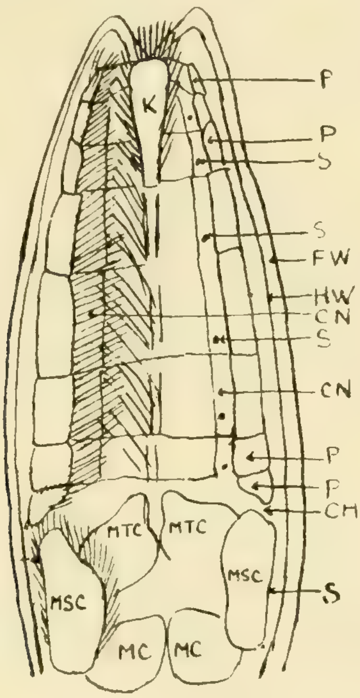
THE RESPIRATORY ORGANS OF A NOTONECTID.

By Stephen Gottheil Rich, M.A.

(*With two text figures.*)

In the Annals of the Entomological Society of America for December, 1910, Mr. J. R. de la Torre Bueno has published an interesting article on the Aquatic Hemiptera. In the course of this article, Mr. Bueno says:

> There are three main forms of respiratory apparatus among the water dwellers, which may be called the *dorsal reservoir and pile*, the *anal tube*, and the *abdominal channel* types. The tracheal systems as such are practically identical in all three forms of air supply. The Corixidæ, Belostomidæ, and Naucoridæ have the dorsal reservoir; the Notonectidæ the abdominal channel; and the Nepidæ the tube type.



He goes on to describe the three types in detail.

The rather meagre description which Mr. Bueno gives of the abdominal channel type of air supply, found in the Notonectidæ, suggested to me that it might be well to undertake the study of this feature. In the Amanzimtoti River, Natal, I was able to secure a good supply of Notonectid material, which, however, I have thus far not been able to identify.

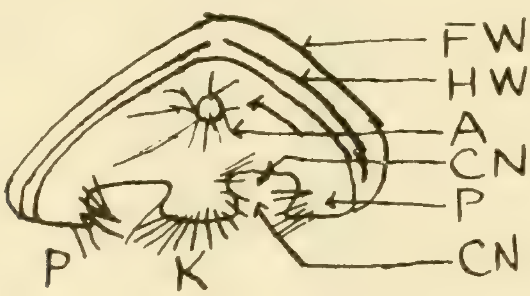
Figure 1 shows the ventral aspect of the abdomen of my material. Mr. Bueno's description, which I quote in full, will here apply:

> It (the abdominal channel) is, however, extremely simple. The abdomen is keeled down the middle, and from this keel spring outwardly towards the sides of the body elastic and fairly stiff and close-growing long

hairs, which meet similar hairs arising from the connexivum edge. There is thus formed a channel on each side of the abdomen which is filled with air, and in which the spiracles are placed. The insects hang in the water abdomen up, with its extremity just piercing the surface film. In most species there are three tufts of hair, which spread out on the surface, leaving an open, water-free spot in the middle which is the point where the connection is made between the abdominal reservoirs and the atmosphere. When totally submerged, the opening closes in some way not well explained so far, although the writer believes that the three tufts mentioned lap over, and in some manner serve to obstruct the entrance of water into the channels. In any case these channels act as storage reservoirs when the insect is in its element. The hairs are not set so near together as to touch, but they are sufficiently close to form an aqueous film at a tension between them which acts to retain the air in the chambers, and at the same time to keep water out. Very little seems to be known in regard to their internal respiratory system. It might seem, though, that it should be simple. The nymphs are not different from the adults in this adaptation.

In my Figure 1, K is the keel bearing laterally projecting hairs, P the pleurite or connexivium, S the spiracles, and CH the channel. The hairs are shown on one side only.

In my material the keel becomes very flat as it proceeds towards the head, and on the basal somites of the abdomen is hardly recognisable as a keel. It is only on the two terminal



somites that it is a true keel. The hairs on it, while longer than those on the pleurite, are much fewer, and appear to play a small rôle in maintaining the air in the channel.

I found a rather interesting prolongation of the channel forwards. As shown in my figure, the channel swerves distally around the coxa of the hind limb, MTC. It passes forward beneath a caudal prolongation of the mesothoracis scutellum, MSC. Near the coxa of the mesothoracic limbs, MC, is a spiracle under this plate. I failed to find more than one thoracic spiracle. I have indicated the swerving part of the channel as CH.

The channel which passes around the hind coxa also communicates with the space beneath the wings, FW and HW. In life there is always a shiny film of air under the basal part of the wings; this air does not extend very far caudally. This would appear to form a supplementary reservoir of air. The hairs on the distal edge of the mesothoracic scutellum form a seal against water over the point where the channel reaches the edge of the wings. The hairs on the caudal part of the scutel-

lum, as shown in the figure, form the water-seal over the swerving part of the channel.

The mechanism for obtaining air and for sealing the opening, at the caudal end of the animal, appeared very clearly in my material. The wings extend a short distance beyond the tip of the abdomen. In life they are the only parts which project above the surface when the animal hangs head downwards. They are at this point closely appressed to the abdomen. I therefore believe that no air enters the reservoir beneath them at this point. The hairs on the keel and the pleurite, pulled outwards by the surface tension of the water as disturbed when the wing-tips emerge, leave between them two holes, one for each channel, through which air enters.

The sealing of the openings takes place automatically when the animal leaves the surface. There is no more surface tension to hold the hairs apart. They are elastic and fly back to their natural position flat against the body, closing the air-channel.

It will be noted that only one of the tufts of hair is on the keel; the other two are on the pleurite on each side. My Figure 2 shows in a diagrammatic way the arrangement of parts at the end of the abdomen. The two channels and the keel, as well as the tufts of hair, appear clearly. The abbreviations are the same as in the other figure.

I have dissected the internal breathing organs of this animal, and find nothing unusual to report. The tracheation is exactly as in most other Hemiptera. The usual principal tracheæ are there, and without modifications of any sort.

(*Read, July 6, 1917.*)

TRANSACTIONS OF SOCIETIES.

SOUTH AFRICAN SOCIETY OF CIVIL ENGINEERS.—Prof. A. E. Snape, B.Sc., M.I.C.E., Past President, in the chair.—"*Salisbury (Southern Rhodesia) water works*": Prof. R. H. **Charters.** A detailed description of various features of the works was given, under the heads of Storage Reservoir, Filters, Gravitation Main, Service Reservoir, High-level Tank, and Distribution System. The entire cost of the works was £58,361.—"*Losses in dams by absorption in inland sub-tropical Africa*": A. H. **Wallis.** The author submitted such evidence as was available to show that the region referred to has been gradually becoming more arid, and urged that efforts should be made to retain in the country, by the construction of dams, the large quantities of rain that ultimately run unconserved to the sea. The author proceeded to discuss the losses sustained by dams through evaporation and percolation.—"*Some experiments on the rate of evaporation of water through films of oil*": Dr. J. R. **Sutton.** The experiments were undertaken in order to test the validity of the suggestion that has been made on various occasions that the enormous loss by evaporation from South African waters might be stopped by keeping a film of oil on the surface of the water. It appeared that at best one gallon of kerosene would save no more than 100 gallons of water, and as on the table-land of South Africa one gallon of kerosene is worth 500 to 1,000 gallons of water, it would not pay to use oil for the purpose of retarding evaporation. From a physical point of view there is considerable interest in the fact that water can evaporate through a skin of oil as much as .02 of an inch thick. The oil probably acts as a sort of Graham's membrane.

SOUTH AFRICAN MYXOMYCETES.

By Augusta Vera Duthie, M.A.

The chief object of this brief paper is to draw attention to the South African representatives of this group, and by so doing to interest members of the Association in their collection. I shall therefore make no attempt to give a detailed account of the life-history of any species, nor refer to the many interesting morphological, cytological and physiological problems connected with the group which call for further investigation. But since many forms are not readily recognizable as Myxomycetes by laymen or botanists who are solely interested in Higher Plants, perhaps I may be excused if, preliminarily, I outline the general characters.

The Myxomycetes, or Mycetozoa (as they are frequently termed), are lowly organisms which in their vegetative or plasmodial state resemble certain of the lower animals; while their fructifications and walled-spores, so admirably suited to wind distribution, are suggestive rather of the fungi within the vegetable kingdom.

The naked mass of protoplasm forming the plasmodium is usually found in decayed wood, on the underside of rotting leaves or stems, or in the soil humus itself. The plasmodium of *Badhamia utricularis*, which was noted in Africa for the first time in 1916, is exceptional in that it feeds on the fructifications of living fungi.

The extent and consistence of the plasmodium may vary within wide limits. In colour it is usually white, yellow, or pink, and it frequently changes in tint as it emerges prior to fructification.

In the great majority of Myxomycetes the spores are formed in the interior of sporangia, plasmodiocarps or æthalia. The individual sporangia are usually small and very fragile, and often of great beauty. Many of them contain an elaborate system of solid or tubular threads—the capillitium—which is of use in spore distribution. The sporangia vary much in regard to shape, colour, nature of wall, and character of capillitium (when present).

The æthalia are cushion-like structures, consisting of densely aggregated and confluent sporangia or plasmodiocarps. In *Reticularia* and *Fuligo* they may be 6 cm. and 20 cm. across respectively. Both these genera are abundant in the Stellenbosch district, and specimens of their æthalia are among the exhibits.

In *Ceratiomyxa*—one of the commonest South African forms—the oval spores are borne on the outer surface of membraneous sporophores.

The group is by no means a large one. It comprises some 49 genera and about 260 species. The largest genus is *Physarum*, with 58 species. *Diderma* comes next with 17, while no fewer than 27 genera are represented by only a single species each.

The Myxomycetes (in the restricted sense) are of no economic importance. This fact, combined with the small size of the fructifications of most species and the delicate or evanescent nature of the sporangial walls, doubtless accounts for the neglect of the group by collectors of the South African fauna and flora.

Welwitsch, in 1855, made a small collection of forms in Angola. Some 22 species have been collected from time to time in the Cape Province and Natal, and sent to Europe. Many of these are now at Kew or in the British Museum.

Kalchbrenner published in *Grevillea*, in 1882, a list of 18 species collected by MacOwan and Wood. Most of MacOwan's specimens appear to have been gathered in the neighbourhood of Somerset East, while Wood's were from Natal. A part of MacOwan's collection is now in Dr. Schöndland's possession.

Mr. Pole Evans has been good enough to allow me to examine the 14 species belonging to the Mycological Herbarium at Pretoria.

So far as I have been able to ascertain, there are no other collections of any size in any of the museums or herbaria in the country.

My own collection, a part of which is now exhibited, includes 16 species not hitherto recorded from Africa, in addition to 24 species and varieties apparently new to South Africa, making a total of 40 new records from South Africa. With the exception of a few specimens sent by friends in Natal and Clanwilliam, most of these species have been found in the Knysna and Stellenbosch districts.

The following list, which contains 24 genera and 73 species and varieties, is, I think, a complete record of the species so far known from South Africa, and I must here express my indebtedness to Miss Lister, of the British Museum, for her kind assistance in the determination of the species—an invaluable help in the absence of type collections and literature.

Ceratiomyxa fruticulosa (Macbr.).
C. fruticulosa var. *flexuosa* (Lister).
C. fruticulosa var. *porioides* (Lister).
Badhamia utricularis (Berk.).
B. affinis (Rost).
Physarum melleum (Mass.).
P. compactum (Lister).
P. mutabile (Lister).
P. nucleatum (Rex).
P. roseum (Berk. and Br.).
P. penetrale (Rex).
P. flavicomum (Berk.).
P. auriscalpium (Cooke).
P. viride (Pers.).
P. viride var. *aurantium* (Lister).
P. pusillum (Lister).
P. nutans (Pers.).

P. natans var. *leucophæum* (Lister).
P. cinereum (Pers.)?
P. vernum (Somm.).
P. sinuosum (Weinm.).
P. bogoriense (Racib.).
P. leucopus (Link).
P. didermoides (Rost.).
P. citrinum (Schum.)?
Trichamphora pezizoidea (Jungh.).
Fuligo septica (Gmelin).
Leocarpus fragilis (Rost.).
Craterium aureum (Rost.).
C. minutum (Fries).
Diderma hemisphericum (Hornem).
D. effusum (Morg.).
D. subdictyospermum (Lister).
Diachæa leucopoda (Rost.).
Didymium difforme (Duby).
D. nigripes (Fries).
D. nigripes var. xanthopus (Lister).
D. squamulosum (Fries).
D. melanospsermum (Macbr.).
Mucilago spongiosa (Morgan).
Stemonitis splendens (Rost.).
S. splendens var. *Webberi* (Lister).
S. herbatica (Peck).
S. ferruginea (Ehrenb.).
S. fusca (Roth).
Comatricha nigra (Schroet.).
C. longa (Peck).
C. typhoides (Rost.).
Lamproderma scintillans (Morgan).
Cribraria argillacea (Pers.).
C. tenella (Schrad.).
C. intricata (Schrad.).
Dictydium cancellatum (Macbr.).
Dictydiæthalium plumbeum (Rost.).
Tubifera ferruginosa (Gmelin).
Reticularia Lycoperdon (Bull.).
Lycogala epidendrum (Fries).
L. flavo-fuscum (Rost.).
Trichia affinis (de Bary).
T. persimilis (Karst.).
T. Botrytis (Pers.).
T. scabra (Rost.).
Hemitrichia clavata (Rost.).
H. Serpula (Rost.).
Arcyria denudata (Sheldon).
A. incarnata (Pers.).
A. insignis (K. and C.)
A. cinerea (Pers.).

A. pomiformis (Rost.).
A. nutans (Grev.).
A. Oerstedtii (Rost.).
Perichæna corticalis (Rost.).
P. depressa (Lib).

Apart from the possibility of obtaining new species in South Africa, or of adding to the number of African representatives of those already recognized, it is of interest to record the geographical distribution of forms and their relative frequency throughout the country, and the extent and direction of variation in individual species.

One of the most abundant and widely distributed species noted thus far is *Physarum vernum*, which differs in its darker spore-colour from the closely related *P. cinereum*. Gatherings of this species from numerous localities in the Transvaal are preserved in the Pretoria Herbarium. I have recently received it from Rhodesia, while in the Knysna district it appears in great abundance a few days after summer rain, covering patches of living grass five or more inches in diameter with a greyish mould-like growth.

In March, 1916, the same species was observed growing on turf within the College Square, as many as nine large patches being scattered over an area of some sixteen square feet. Perhaps the most variable species found in South Africa is *Physarum mutabile*. A form of this from Pretoria with stalked cylindrical sporangia, another from Knysna with sessile sporangia, and a third with expanded plasmodiocarps, are exhibited side by side.

Many of the specimens of *Reticularia lycoperdon* collected in the Knysna district develop from a white plasmodium which rapidly changes to flesh-pink. The small fragile æthalia with copper-coloured surface walls are very different in appearance from the large silver-grey fruit bodies with smooth cortex which are so abundant on pine-stumps in the Stellenbosch district and at Kirstenbosch.

I am glad of this opportunity of enlisting the help of students and general collectors in various parts of the Union, and shall be grateful for any specimens that may be sent to me from time to time, as well as for notes as to habitat, colour of plasmodium, etc.

While decaying vegetation in native forest forms perhaps the best collecting ground for the fructifications, they are found on old logs, bark, the underside or broken ends of fallen branches, near the surface of heaps of straw and dead leaves, and not infrequently on living moss, seedlings, etc. The warm moist atmosphere of a greenhouse seems specially favourable; representatives of six genera have appeared in the plant-house on the College Square.

The specimens should be well dried before being packed, as they are liable to mould. If they are to be kept for any

time it is well to use plenty of napthalene to prevent destruction by insects. The sporangia travel fairly well if they are first wrapped in crumpled paper and then packed closely in a tin or box.

Specimens may be sent by sample post; and I shall be happy to refund the cost of postage.

(*Read, July 4, 1917*).

TRANSACTIONS OF SOCIETIES.

ROYAL SOCIETY OF SOUTH AFRICA.—Wednesday, April 17th: Prof. J. D. F. GILCHRIST, M.A., Ph.D., D.Sc., F.L.S., C.M.Z.S., President, in the chair.—"*Luminosity in a South African earthworm, and its origin*": Prof. J. D. F. **Gilchrist** Luminous earthworms are found on the slopes of Table Mountain. The luminosity proceeds from a discharge from the mouth and anus, which consists of cells heavily laden with inclusions of different kinds. The smaller inclusions consist of a substance allied to fat, by the oxidation of which the light is produced. The cells arise from the body cavity, and are discharged into the anterior and posterior parts of the alimentary canal by definite communications between the cœlum and alimentary tract.—"*Note on the adjugate of Bezout's eliminant of two binary quantics*": Sir T. **Muir**.—*On the genera Diplocystis and Broomeia*": I. B. **Pole Evans** and Miss A. M. **Bottomley.** Some specimens of *Diplocystis* have recently been obtained by the authors from Portuguese East Africa, and this is the first recorded African occurrence of the genus. The African material is not identical with that from Cuba, and the authors describe it as *Diplocystis Junodii*, n.sp.—"*South African Perisporiaceæ, II: Revisional notes*": Dr. Ethel M. **Doidge.** A revision, due to work on a number of fresh collections, of a previous communication on the subject by the author.—"*Fresh-water snails as a cause of parasitic diseases*": Dr. F. G. **Cawston.** The author describes a number of snails collected by him from various districts in South Africa, and found to be infested with the cercarial stages of trematode worms.—"*Colour and chemical constitution, Part II: The remaining phthaleins*": Dr. J. **Moir.** The author described the absorption spectra of complex phthaleins, partly duplex compounds of the phenol-anthol type, and partly of a new class (*e.g.*, thymol-naphthol) derived from thymol-benzoic acid.

THE DECIMAL SYSTEM; MONEY, WEIGHTS AND MEASURES.

By William James Horne, A.M.I.C.E.

I have nothing new to add upon the subject; there has already been a paper upon it from Mr. R. T. A. Innes.* Since Mr. Innes' paper, others have appeared; namely; the resolutions adopted by the National Advisory Board for Technical Education,† based upon a memorandum prepared by Professor Bohle, a lecture by Mr. H. Allcock, given at the Institution of Civil Engineers, London,‡ and the Conference arranged at Johannesburg§ by the Witwatersrand Centre of the South African Association for the Advancement of Science. The following remarks are not wholly original; I have summarised various opinions in order to arouse discussion.

The advantages of the introduction of a decimal system would concern (*a*) education and (*b*) commerce. The educational advantages of the change would not be likely to weigh so heavily with Government as the commercial advantages might. It appears desirable, therefore, that the Institute of Bankers and the Association of Chambers of Commerce of South Africa should take independent action in addition to combining with the Association as they have done. The decimal system is most useful to those countries that have manufactures which they desire to export to countries already possessing a decimal system; the best time for the introduction of or change to a decimal system in such a country is before that country is about to manufacture for export. The change should be made, therefore, in South Africa now.

Coinage.

The system of decimalising the coinage detailed by Mr. Innes is that which has been agreed upon as suitable for the British currency. Foreigners have difficulty in estimating the value of our coins in terms of theirs when visiting Great Britain and those Overseas Dominions using the coinage of the Royal Mint; we have practically no difficulty in estimating the value of our coins in terms of theirs when theirs is a decimal system. The proposed change would therefore give greater confidence to those purchasing from us. In addition to the simplified ruling of account books and ledgers that would result, errors in adding and striking a balance would be less liable to occur, such as that elusive ten shillings difference between the two sides of the balance sheet.

The time appears opportune to press the point, as the question of opening a Union Mint was raised not long ago. By

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* Rept. S.A.A.A.S. (1916), Maritzburg.
† Sixth meeting of the Board at Capetown, 1st March, 1916.
‡ *The Times* Engineering Supplement, March 30th, 1917.
§ Chamber of Mines, Johannesburg, April, 1917.

eliminating the half-crown and coining a new tickey to the value of 2.4d. (of the present copper coinage) and issuing five to the shilling (or half-florin) the public would be gradually prepared for the complete adoption of a decimal coinage.

In addition to the countries mentioned by Mr. Ingham at the Johannesburg Conference, Mr. Allcock mentions in his London lecture Canada, Newfoundland, Egypt, the Straits Settlements, Ceylon, British East Africa and Uganda. It may, however, be pointed out that the German mark, with its nickel subdivisions, circulates in the British South West African Protectorate (late German South-West Africa), while in German East Africa the rupee (15 to the £=1s. 4d.) circulates; the Germans sub-divided the rupee into 100 hellers; the natives, however, adhered to the "anna" (penny) of 16 to the rupee, each anna equal to 4 pice (= farthing). In British East Africa, Uganda, and Zanzibar both Indian and English coins circulate. India would appear to be the difficulty in the way of the adoption of a decimal coinage for the Overseas Dominions. It was not a simple matter for Sir Guilford Molesworth when he introduced the present decimal coinage into Ceylon; it took the reform party five years to educate the people through a Decimal Association, but when the change was made no difficulty was experienced with the new coinage. In view of the diversity in units of monetary value employed by different countries, and of external influences such as fluctuation in the rate of exchange, it is clear that a universal system of coinage for all the countries of the world is unattainable, since such fluctuations would prevent international coins of the same face value having always the same actual value. Such influences, however, do not affect

Weights and Measures.

The rapid adoption of the metric system in all countries, except Great Britain and the Dominions, has limited the choice to one between the British Imperial system and the International Metric System. The advantages of the metric system is that it is an international language based upon a scientific system which itself has the advantages of a decimal relation between units, a very simple relation between the units of length, area, volume and weight, together with a simple and self-defining series of names for these units.

It is the change in the unit of length which presents serious difficulty. The change to the kilogram as the unit of weight could be easily effected; but its adoption alone would not provide the very great flexibility and simplicity in calculation which the complete system allows. The greatest trouble and expense would occur in the engineering and transportation industries. The American Society of Mechanical Engineers and the firm of Sellars (comparable with Whitworth in England) decided against the adoption of the metric system and decided to adhere to the English inch as the unit of length. Sir Archibald Denny suggested that, since the metre is 39.37 inches, it would provide

the necessary flexibility if the metre were increased to 40 inches in length. This would involve a change in the metric standard of length throughout 45 countries. The alternative would be for the Engineering Standards Committee to compile sufficiently equivalent metric sections owing to the impossibility of useful conversion from the present standard sections in inch units to the metric system . With reference to the cost of the transportation industry, Mr. Aspinall, manager of the Lancashire and Yorkshire Railway, estimates that the cost merely of re-tareing from 1,400,000 to 1,600,000 wagons in use would be £400,000, without counting the cost of regraduating weighing machines, gas and water meters, etc.

Few people realises that the Navy uses a decimal system of lengths, thus:—

The fathom=1/1000 of a nautical mile (Definition).
100 fathoms=1 cable's length.
10 cables =1 nautical mile.
=1,000 fathoms.

There are two measures of capacity, the "liquid" and the "dry." Many liquids are actually sold by weight, and every purchaser can demand to have his or her "dry" purchases weighed by the seller; as a matter of fact wheat, mealies, bran, beans, etc., are always sold in South Africa by weight. The sale of potatoes by the bucket—mentioned by Professor Bohle—is illegal, like sale by muid and schepel, as the only legal standards of capacity in South Africa are the bushel and gallon, quart and pint.

Engineers are by no means unanimous on the change to the metric standard of length, not because it would not be as easy to calculate, but because of the cost of re-standardising rolled sections, bars and shafts, drills and screw threads in order to give even metric sizes to these; to this also would have to be considered the cost of carrying stocks of both inch and metric standards during the transitional period. The change, therefore, could only be spread over a number of years, a beginning being made with the redesigning of sections, etc., by the Engineering Standards Committee.

The Government of India, by the Weights and Measures Act of 1871, adopted the metric system, but it was never put in force and is a dead letter. In 1897 the use of metric weights and measures was permitted by law in Great Britain; in 1907 Lord Belhaven's Metric Bill was rejected. Some nine or ten years ago the use of the metric system in the Union was permitted by law. Permissive use side by side with existing systems will not bring the better system into use as long as one accepted way of getting extra profits is to confuse the purchaser; consequently only an Act legalising the metric system will protect the public from petty depredations. The question of the change will not be decided by sentimental or educational reasons, but by the cost to the commercial and the manufacturing communities.

and that itself will be decided by whether our internal or our external trade is the more important.

Bibliography.—" An Enquiry into and an Explanation of Decimal Coinage and the Metric System of Weights and Measures," 3rd ed., by Edwyn Anthony. Publishers: Routledge, at 2s. 6d. 1906."

(*Read July* 6, 1917.)

IONISATION OF GASES AND THE ABSORPTION OF *X*-RAYS.

By Lewis Simons, B.Sc.

(*Not printed.*)

THE PLOUGH.

By William Shaw Hamilton Cleghorne, B.Sc., A.M.I.Mech.E.

(*Not printed.*)

MECHANICAL REFRIGERATORS.

By Henry Walter Bull.

(*Not printed.*)

SIMPLE EXPEDIENTS IN EXPERIMENTAL CHEMISTRY.

By Prof. Berthault de St. Jean van der Riet, M.A., Ph.D.

(*Not printed.*)

NOTE ON A NEW GENUS OF COPEPODA FROM A FRESH-WATER FISH.

By Prof. Ernest James Goddard, B.A., D.Sc.

(*Not printed.*)

A PLEA FOR GREATER ATTENTION TO PHYSIOLOGY IN THE TEACHING OF ZOOLOGY.

By Prof. Ernest James Goddard, B.A., D.Sc.

(*Not printed.*)

DESCRIPTION OF A BACTERIUM WHICH OXIDIZES ARSENITE TO ARSENATE, AND OF ONE WHICH REDUCES ARSENATE TO ARSENITE, ISOLATED FROM A CATTLE-DIPPING TANK.

By Henry Hamilton Green, D.Sc., F.C.S.

(*Abstract.*)

(*Printed in Annual Report of the Director of Veterinary Research, Pretoria.*)

By means of a combination of enriching and plating methods a number of arsenic-resistant organisms have been isolated from the cattle-dipping tank at Onderstepoort.

Oxidizing Organism.—This appears to be a new organism, and has been provisionally named *Bacterium arsenoxydans*. According to the classification system of the Society of American Bacteriologists it would have the group number 212.3331033. It is the causal organism in deterioration of arsenical dips, and so far as has been ascertained, it appears to be the only one to which rapid oxidation is to be ascribed. Its dimensions are variable, usually 1 μ to 3 μ in length and 0.3 μ to 0.6 μ in breadth, slender forms predominating. Involution forms are larger, and vary considerably in size and shape. It stains well with ordinary stains, shows a beaded structure, and is gram-negative. It is generally non-motile, although motile forms which readily lose their motility have been observed.

Apart from its its denitrifying activity and its power to oxidize arsenite to arsenate, its characteristics are rather negative. Apart from the negative characters indicated by the group number it does not produce alkalinity in milk media, produces neither indol nor sulphuretted hydrogen, nor any characteristic odour in bouillon. It grows either poorly or not at all in synthetic media, such as Uchinsky's, Giltay's or Cohn's. Growth on agar is slow, but good; on gelatine, poor, and may fail; on alkalinized potato, slow and uncertain, but may be good; in organic media, such as bouillon, peptone, hay infusion, is good, but slow. Plate cultures on agar, and agar slopes, are not unlike those of *coli* except that growth is slower and more compact. It is easily differentiated from most of the commoner organisms, especially those of the *coli* group, by its high tolerance for arsenite and its capacity to oxidize this to arsenate. The limit of tolerance is about 1 per cent. As_2O_3, as arsenite and oxidation can proceed slowly in concentrations as high as 0.8 per cent. The rate of oxidation, under suitable conditions, increases as the concentration of arsenite decreases. At 0.2 per cent. As_2O_3, oxidation, after light inoculation, may be complete in five or six days. Oxidation proceeds best in a faintly alkaline medium, being inhibited by very slight acidity and rapidly coming to a

standstill in neutral media unless the buffer effect is sufficient to absorb the change in H ion concentration accompanying the transformation of alkaline arsenite into neutral or acid arsenate. The reaction limits are approximately assessed as

$$P_H\ 6.8 \text{ to } P_H\ 10.$$

Although the organism does not grow under anaerobic conditions in bouillon, it does so readily in presence of nitrate. Arsenate, however, cannot take the place of nitrate, and although arsenite is so vigorously oxidized to arsenate under aerobic conditions, the reverse change of reduction is not effected under anaerobic conditions.

The organism is physiologically very active, and relatively small numbers are capable of converting large amounts of arsenite into arsenate, even in mineral media containing only very small amounts of organic matter.

Reducing Organism.—This organism, which reduces arsenate to arsenite with great rapidity, under suitable conditions, is a vigorously motile bacterium with the group number 222.2331033. It appears to belong to the colon-typhoid family, from other members of which it can however be easily differentiated by its high resistance to arsenite and its outstanding capacity to reduce arsenate to arsenite. It has been named *Bacterium arsenreducens.* It has peritrichic flagella, usually four to eight in number. It is a polymorphic, rod-shaped organism, usually about 2 μ in length by about 0.4 μ in breadth, but it may vary from 1 μ to 6 μ in length and 0.3 to 0.6 μ in breadth. Disposition to chain formation is marked, and old bouillon cultures may show as many as 10 or 20 rods in one long motile chain. It stains well with all ordinary stains and is gram-negative. Occasionally bipolar staining may be observed. Litmus milk is rendered slightly alkaline, but no coagulation or proteolysis occurs.

Although growth under anaerobic conditions is moderate, aerobic growth is much better, and in suitable media complete reduction of 0.2 per cent. arsenate can occur in 48 hours even on free exposure to air in liquid layers only 1 cm. deep. The organism can tolerate up to 1 per cent. As_2O_3 as arsenite, and arsenate reduction may proceed almost to this limit.

In mixed cultures with the oxidising organism reduction of arsenate or oxidation of arsenite can be made to proceed at will by simply varying the composition of the medium. In attenuated media bufferized with potassium phosphate, oxidation occurs. On enriching the medium by the addition of glycerine, glucose, or fresh stable manure, the reducing organism outmultiplies the oxidizing organism and reduction occurs. The significance of this is discussed in relation to dipping tanks in the field and the frequency of their use.

Other Arsenic-Resistant Organisms.—A number of other organisms, which neither reduce arsenate nor oxidize arsenite,

have also been isolated from the dipping tank. Amongst these are members of the *putidum* group, one of which, *B. fluorescens non-liquefaciens,* can grow freely in concentrations up to 1 per cent. As_2O_3 as arsenite.

(*Read, July* 5, 1917.)

THE CLASSIFICATION AND AFFINITIES OF THE HIRUDINEA.

By Prof. ERNEST JAMES GODDARD, B.A., D.Sc.

(*Not printed.*)

SOME FIELD RESULTS OF FERTILISING MAIZE.

By JOHN FREDERICK WILLIAM GATHERER.

(*Printed in "Agricultural Journal of South Africa," August,* 1917.)

THE HEMICHORDATA AND THEIR SIGNIFICANCE IN RELATION TO THE INVERTEBRATA AND CHORDATA.

By Prof. ERNEST JAMES GODDARD, B.A., D.Sc.

(*Not printed.*)

NOTE ON THE ORIGIN OF METAMEVISM.

By Prof. ERNEST JAMES GODDARD, B.A., D.Sc.

(*Not printed.*)

THE GRAIN BUG OR *STINKVLIEG* (*BLISSUS DIPLOPTERUS* DIST.)

By CHARLES WILLIAM MALLY, M.Sc., F.L.S., F.E.S.

(*Not printed.*)

LINSEED OIL AS AN INSECTICIDE.

By CHARLES WILLIAM MALLY, M.Sc., F.L.S., F.E.S.

(*Not printed.*)

OUR LANGUAGE AND THE NATIVE PUPIL.

By Stephen Gottheil Rich, M.A.

This paper aims to clear ground for positive construction in the matter of teaching the English language to native pupils. It is thus preliminary in its nature. Furthermore, it is based on work among Zulus only, and therefore may fail to take into consideration conditions among other native peoples. It rests mainly on observations and experiments made since February, 1916, at the Amanzimtoti Institute, Natal.

How early should we begin teaching English?

In the practising school attached to the Amanzimtoti Institute, a thorough-going scheme of oral lessons in English for all classes was begun in 1915. The infants of 1915, now in Standard I, have, as a result of this, a command of English practically equal to that of the average native pupil who comes from the day-schools to Standard V of the Institute. In March last, I was able to give nature-study lessons, entirely in English, to the children of Standard II in the practising school.

A more important result is that these children are remarkably free from the usual native errors. At so young an age it is impossible to teach a language by means of translation. A direct method, with objects, actions and commands, had to be used. The happy result has been that the usual errors due to literal translation of Zulu idiom are avoided. It is an exceptional teacher who can avoid the use—and the abuse—of translation when teaching pupils who are old enough to translate.

Observations have indicated to me that these young children, thus taught, are really bilingual. They do not simply think in Zulu and translate. They think in English when using English. I adduce as principal evidence of this their facility within the limits of their vocabularies—a facility impossible under like conditions if they translated.

I would therefore urge that English be made a prominent feature of the infant-class work. As a guide to the time to be devoted to the subject, I may state that at Amanzimtoti it has received the same amount of time as reading.

My colleague, Mr. Frank Ostermann, and I have watched with some care the time and difficulty involved in correcting in Standard V and upwards the errors of those who learned English in the usual way. In our first year Teachers' Training classes, which follow Standard VI, we have worked half a year at eliminating some eight or nine common errors. Our success here, as with similar work with Standard V last year, has not been unduly gratifying. We find that the habits of speech learned younger persist unless a most disproportionate amount of time is given to their correction. The following sentences illustrate the types of error in question:

"My coat makes me *to be* warm."

"A boy saw a lizard which he caught *it*."

"The ntotoviyana is a locust that *is smelling.*"
"I am *too* hungry." (*Too* for *very.*)
"He *use to* do it" for "He does it." (Misuse in present tense of auxiliary, which is past tense only.)
"The cow is the animal which is useful." (Misuse of article.)
"Thet shesh ease thee new one aaav ours." (Mispronounciation of short vowels, of sound of *ur*, of *ch*. "Shesh" = church.)

The small children who learned English in the practising school do not make these errors. Their speech-centres and vocal organs have not yet become set to Zulu intonation and idiom. The advantage here is patent.

From the discussion of when to teach English, let us pass to the question of what the method and content should be.

Our results have been most promising with *oral* work as the great staple of instruction. Reading aloud does not appear to be an effective means of gaining power in English. In my own class of first-year Teachers' Training students, those who pronounce correctly when reading still fail, in two-thirds of the cases, to transfer this correctness into their speech. The same was true of our second-year Teachers' Training class and our Standard V, in 1916.

We have had much success in the use of a modified form of reading, however. On small sheets we printed specially composed sentences, each containing as many cases of possible error as we could include. We drilled students on these sentences. Some of the sentences were:

A girl sees an angel.
Put the sheep into the ship.
One of the boys was Charles.

We used sentences on the blackboard as well as groups of confusing words:

That bat is like a bird.
It—eat.
Of—off.
Ship—chip—sheep—cheap.
Bat—bet—bit—but.
Bad—bed—bird.
Then—than.

Wherein our advantage over reading consisted, was in the immense amount of practice or drill on exactly the words which caused difficulty.

This device is, of course, more useful for the correction of errors than for original teaching of words. It has, however, been useful in the lower standards as a variant on ordinary oral drill.

The oral language-lesson itself must be chosen carefully. Our surest as well as swiftest results were secured by the use

of action-lessons. The teacher put a block on the desk, saying, "I put the block on the desk." She then commanded the children to do the same. She asked what had been done. She made the children correct each other's mistakes in action or explanation. She corrected errors as soon as made.

An excellent means which I have used successfully is an adaptation of the great enemy word, "Verboten." When an error in using a word or phrase became prevalent, we gave oral and written lessons in which the use of the word or phrase in question was totally or nearly totally prohibited. For example, Standard V had oral composition about a locust, previously studied in nature-study, with the aim of seeing who could use the word "and" the fewest times. In a higher class we prohibited the words "too" and "by" entirely, in compositions, for a whole quarter; we allowed "and" only twice in a page. There have been gratifying results from a similar prohibition of the present participle in all its uses.

This device is most excellent in securing ease and flexibility of language. Its use makes the pupils discover and practise improved forms of expression.

I pass now to a matter which may offend some persons. I refer to the effect of the extensive use of the Bible in the schools for natives. We have heard much of our Bible as a "well of pure English undefiled." But the plain fact is that it is no such thing as far as natives are concerned. It is a well of archaisms that are to-day errors. Let me be specific. In Psalm 23 is the phrase, "Thou makest me to lie down in green pastures." In contemporary usage the word "to" after *make* is erroneous. The subjunctive mood is used perhaps four times as much in the Bible as in the best current writing. In the third person singular this creates permanent confusion: many natives form an unbreakable habit of saying, "he have," "he sing," etc., on all occasions. In current usage the future tense is, "I shall go, you will go, he will go, we shall go," etc. In the Bible, "I will go" is regularly used for the simple future tense, instead of for the expression of determination. The use of "thou shalt" and "he shall" in frequent commands in the Bible further muddles matters. The results of this antique usage are that hardly one native who finishes Standard VI can use the correct modern forms for the future tense. The use of antique phrases, such as "believe on," and obsolete past tenses such as "bare," "drave," leads to further confusion. The unsystematic punctuation of the Bible, the lack of quotation marks, and the overuse of the word "and" are further stumbling-blocks.

This is not advocacy of the withdrawal of this book of ethics from native schools. I do, however, ask for the use of any one of the many good modern-speech versions. If the Bible be worth using, let us use it in the most advantageous form. The alleged literary merits of the older versions do not enter into this question.

A decided waste of time is found in the present forms of

instruction in English grammar. It is not clear, for example, what purpose is served by teaching natives the details of parsing, the kinds of pronouns, the seven different uses of the objective case, etc. It would seem far more effective to use this time for drill in correct usage and pronounciation. The grammar usually taught is notorious for not having any effect in preventing errors in speech and writing.

The following tentative outline for instruction in grammar is based on a short survey to show what parts of grammar have actually been useful to the students at Amanzimtoti in the last year and a half.

1. Drill on the conjugation of the verb. The progressive and emphatic forms should be omitted because they are abused if known.
2. Drill in simple analysis of sentences.
3. Practice in recognizing clauses and their uses. Much practice in writing sentences with given kinds of clauses in conversion of sentences.
4. Practice in the use of the difficult pronouns: relative and interogative.
5. Thorough drill in punctuation.
6. The sequence of tenses, with much drill in indirect discourse. Indirect questions must be thoroughly taught.
7. Drill in correct uses of prepositions.

Finally, I wish to revert to the matter of pronunciation. At Amanzimtoti there are English, Scotch, American, Dutch, and Colonial members of the teaching staff. To prevent the students from acquiring from any of us peculiarities of speech not correct in this country, we have given special attention to instruction in pronunciation.

We found it necessary to drill extensively on all the short vowels, and on a few common words such as " a," " the," " of," which were made so long by the students that they were nearly unrecognizable. We found extensive drill necessary on the vowel-sound in *bird, church*. The students seemed totally unable to get this sound until we told them to " stick out their lips like Hottentots." The sound of *ch* was the only difficult consonant. We exaggerated each point slightly; after the inevitable slipping-back, we secured correct pronunciation.

I wish to urge on all who educate natives the necessity of teaching pronunciation most carefully and systematically.

(*Read, July* 3, 1917.)

Grey College Herbarium.—Mr. J. Burtt-Davy points out that in his presidential address before Section C, at the Stellenbosch meeting,* he omitted to mention the herbarium of plants of the Orange Free State, deposited at the Grey University College, Bloemfontein. This herbarium contains some 3,000 sheets.

* See this volume, pp. 64-82.

UPON THE FATE OF ARSENIC AFTER INGESTION BY, AND INJECTION INTO, LIVE-STOCK, AND AFTER ABSORPTION THROUGH THE SKIN IN DIPPING.

By Henry Hamilton Green, D.Sc., F.C.S.

(*Abstract.*)

(*Printed in Annual Report of the Director of Veterinary Research, Pretoria.*)

Experiments have been carried out on sheep, horses, and cattle, the bulk of the data being derived from experimental work on the administration of arsenite in the treatment of wire-worm (*Hæmonchus contortus*) in sheep. Numerous protocols are presented to show the distribution of arsenic in the stomach system and intestinal tract at various intervals after dosing, and the rate of elimination in urine and fæces is dealt with in considerable detail. The distribution of arsenic in the different compartments of the stomach of the sheep depends upon the path taken in swallowing. If the animal takes material voluntarily, as in the form of a lick, the greater proportion passes into the rumen, and thence slowly through the abomasum into the intestine. If the animal is forcibly dosed, as with a spoon, the path is more arbitrary, and a considerable portion may pass direct to the abomasum, from which it is more rapidly passed on into the intestine. Duration of sojourn of arsenic in the stomach system is discussed.

Rate of absorption and elimination of soluble arsenic is rapid, and the path of elimination of either arsenite or arsenate of sodium is chiefly by the kidneys, about four-fifths of the dose appearing in the urine, and only one-fifth (or less) in the fæces. With arsenious oxide powder, absorption is slow, and the relative proportions eliminated in fæces and urine are reversed.

After administering soluble arsenite by the mouth, 25-45 per cent. of the dose may be eliminated in the urine within 24 hours, and as much as 60 per cent. within 48 hours. By the fourth day the rate of elimination falls to a few per cent. of the dose, and thereafter there is a gradually decreasing output, which tails off to a fraction of a milligram per day after eight or nine days. Traces of arsenic, however, are frequently detectable for another week or two, but the amount is too small to be of any physiological consequence. In the fæces the maximum output usually occurs in the third day, and by the seventh or eighth day the solid excreta are practically arsenic-free.

When soluble arsenite is injected straight into the blood-stream the path of elimination is almost wholly through the urine, the amount entering the gastro-hepatic circulation being

very small. Elimination begins at once, and several per cent. of the injected amount may appear within half an hour. As much as 70 per cent. may appear within 24 hours, the amount then rapidly tailing off until at the end of five or six days over 90 per cent. may have been recovered. Further elimination is gradual and trifling in daily amount.

After injection into the blood-stream the concentration of arsenic in the blood falls with extraordinary rapidity by temporary distribution over the tissues. The rapidity and nature of this distribution is discussed.

The data for horses and cattle are more limited, largely owing to the greater experimental difficulties presented by the collection of fæces and urine of large animals. With the horse, however, the absorption of soluble arsenic seems to be less complete, and a larger proportion of any given dose appears in the fæces.

The amount of arsenic eliminated by cattle and horses after dipping in arsenical tanks is very small, and the currently accepted data are shown to be erroneous. Currently accepted data for arsenic retained in the skin of dipped animals are also shown to be much too high. The bearing of these points on the *modus operandi* of tick destruction is discussed.

The quantity of arsenic to be expected in organs such as the liver in cases of arsenical intoxication, is considered, and the difficulties of diagnosing arsenical poisoning in stock in South Africa are discussed.

(*Read, July* 5, 1917.)

NEBULÆ AND NOVÆ.—Dr. V. M. Slipher contributed some time ago to the Proceedings of the American Philosophical Society a paper on Nebulæ, in the course of which he remarked that it has for a long time been suggested that the spiral nebulæ are stellar systems seen at great distances. This is the so-called "island universe" theory, which regards our stellar system and the Milky Way as a great spiral nebula which we see from within. This theory, Dr. Slipher considers, gains in favour by reason of the spectrographic observations conducted at the Lowell Observatory since 1912, but he thinks that, if our solar system evolved from a nebula, as was long believed, it was probably not one of this class of spirals. In the course of some notes on variable stars contributed to the Report of the Council of the Royal Astronomical Society,* the Rev. T. E. R. Phillips declares that it is unthinkable that the apparent relationship between Novæ and spiral nebulæ in so many instances can be fortuitous. The Novæ must almost certainly be *in* the nebulæ, and this circumstance, taken in conjunction with the well-known clustering of Novæ in our galaxy towards the galactic plane, seems highly significant, and gives striking support to the theory that the spirals are "island universes."

* *Monthly Notices* (1918), 78 [4], 300.

NOTE ON THE ANALYSIS OF SODA-SULPHUR DIPS.

By Bertram Joseph Hill.

(*Abstract.*)

Several soda-sulphur concentrates are now on the South African market, sold primarily for use as sheep-dip in the eradication of scab. One of these, indeed, has been marketed as a lime-sulphur dip although calcium is practically absent. Since sodium polysulphide is just as valuable as calcium polysulphide (if not more so) in the treatment of scab, nothing is to be gained by such confusion of specification.

In the analysis of soda-sulphur dips, the direct iodine titration method, largely used in the United States for lime-sulphur concentrates, is not applicable. In this process the "monosulphur equivalent," or "base in combination with sulphur as sulphide," is determined by running in iodine until the yellow colour of polysulphide is completely discharged, and thiosulphate then determined by continuing the titration to starch end-point. In dealing with soda-sulphur concentrates a certain amount of sodium carbonate is always present, and although this is not directly registered to iodine, it has the effect of raising and obscuring the reading for "monosulphur equivalent." If by chance any free caustic soda is present, both iodine readings may be vitiated. In calculating monosulphur equivalent against total sulphide sulphur, in order to determine the nature of the polysulphides present,, an erroneously narrow ratio may then be obtained, and this may lead to unjust suspicion that the harmless higher polysulphides are admixed with depilatory monosulphide. It is therefore maintained that the older method of determining monosulphide equivalent by titration with ammoniacal zinc, and subsequent determination of thiosulphate in the filtrate by iodine titration, gives more reliable results. An ordinary acid titration to methyl orange should also be carried out in order to obtain a rough indication of the amount of carbonate present. If acid titration is higher than zinc titration, the difference is usually to be attributed to carbonate, although theoretically it might be hydroxide. If the zinc titration is higher than the acid titration, hydrosulphide is indicated. If the two titrations are the same, it indicates that all the titratable base is in combination with sulphur, or that carbonate is in equilibrium with hydrosulphide.

Carbonate, hydroxide, and polysulphide (tetra or penta) can co-exist together in solution without immediate interaction A little carbonate is therefore of no consequence in a freshly-made dip, but it is considered at least possible that on prolonged storage slow reaction with polysulphide may take place with pos-

sible formation of depilatory hydrosulphide. This point, however, has not yet been specificially investigated. In the event of appreciable amounts of depilatory lower sulphide being present, the ratio of monosulphur equivalent to total sulphide sulphur will of course be unusually narrow. In well-made soda-sulphur dips this ratio usually lies between 1 : 4 and 1 : 5, *i.e.*, a mixture of tetrasulphide and pentasulphide is indicated. If the ratio is much narrower than 1 : 4 the dip should be viewed with suspicion, and tested by steeping washed wool in it at tank dilution, and then subjecting the fibre to microscopic examination for depilatory action.

In reporting upon the efficacy of a soda-sulphur concentrate in relation to the eradication of scab, the content of polysulphide sulphur should be made the basis of calculation. Other constituents, such as thiosulphate, are of negligible parasiticidal importance, and need not be considered in evaluation. The dilution recommended for tank strength should be such that the polysulphide does not fall below 0.6 to 0.7 per cent.

The following sample analyses illustrate the composition of four different concentrates:—

	Grams per 100 c.c.			
	A.	B.	C.	D.
Total Soda, Na_2O	12.90	17.95	11.50	17.15
Sulphur Total	23.58	31.15	16.45	23.40
Sulphur as Thiosulphate	2.04	7.35	6.75	6.42
Sulphur as Sulphite and Sulphate	.74	.31	.25	.36
Sulphur as Sulphide and Polysulphide	20.80	23.49	9.45	16.62
Monosulphur Equivalent	4.62	5.11	2.20	5.70
Ratio M.E.: S.S.	1 :4.5	1 :4.6	1 :4.3	1 :2.9
Dilution for Tank Use recommended by the vendors	1 :30	1 :40	1 :30	1 :50
Hence Concentration of Polysulphide Sulphur at Tank Strength ..	.69	.59	.32	.33

Samples A and B are permissible, sample B being practically on the 0.6 per cent. limit for polysulphide sulphur (regarded as the minimum for efficiency in the treatment of scab), and sample A being well above it and equivalent to a well-prepared home-made dip. From the analysis B is suggested as being manufactured from caustic soda and sulphur, while A, in which the thiosulphate is very low, is suggested as being derived by reduction of sodium sulphate. Sample C would also be permissible if used at twice the strength recommended by the vendors. There is no evidence of admixture with depilatory lower sulphide, but the tank concentration only works out at half the strength regarded as necessary. It could not, therefore, be relied upon to cure scab if used according to the specified direc-

tions. Incidentally the proportion of the total sulphur which is present as ineffective thiosulphate is unusually high.

Sample D cannot be regarded as permissible. The polysulphide ratio of 1 : 2.9 suggests admixture with lower, possibly depilatory, sulphides, and, indeed, on comparing zinc titration with acid titration, evidence of the presence of a considerable amount of hydrosulphide was obtained. The tank dilution recommended also gives only half the strength of polysulphide sulphur regarded as a reliable minimum, and in view of the narrow polysulphide ratio, it might not be safe to dip at higher concentrations. The exact extent of damage to skin or fleece, which might result from its use, would be difficult to assess without an actual dipping trial, but from a manufacturing point of view sample D is an inferior article, and there is no reasonable justification for its presence on the market.

(*Read, July* 5, 1917.)

Bantu Mentality.—In a recent issue of *Science Progress,** Mr. A. G. Thacker discusses an essay on the mental development of the South African Native, contributed by the Rev. A. T. Bryant to the *Eugenics Review*.† Mr. Bryant thinks that up to the time of puberty the Bantu boy is rather in advance of the European boy, but that subsequently not only does arrest of mental development occur in the Bantu, but there is even retrogression. In the female Bantu, both youthful and adult, Mr. Bryant could not find any inferiority compared with the European female. In this connection Mr. Thacker makes the following comments: "If the Bantu woman be really the mental equal of the white woman, is she not in advance of her own men? Further, if the average of the Bantu women is equal to the average of European women, it is very possible, though not a necessary consequence, that the range of variation in the females of the two races is equally great. Now it will not be disputed that the mental powers of a considerable minority of white women—probably about 10 per cent.—are, even in those departments, such as ratiocination, which, as Romanes pointed out long ago, constitute the special masculine province, appreciably superior to the powers of the average white man, whilst a small minority of women soar far above the ordinary man. Are we to believe that the Bantu nations have possessed intellects such as these? It may be so; the intellects may have existed, and have yet been unable to make themselves felt owing to adverse social conditions. The idea must not be scouted merely because to most of us it happens to be unexpected."

* (1917), **12**, 230.
† (1917), **9** [1].

BINET-SIMON TESTS ON ZULUS.

By Stephen Gottheil Rich, M.A.

The results reported in this paper were gathered by Mr. H. Redfern Loades, then of Durban, and now of Uitenhage, and the present writer, in May and November, 1916. The actual testing is mainly Mr. Loade's work, but the collation of results is mine. The conclusions are in the main mine, and do not represent adequately Mr. Loades' views.

We undertook this work without knowledge of the work then in hand by Inspector C. T. Loram, Ph.D., which was so interesting a feature of the meetings at Maritzburg in 1916. We had the pleasure of seeing some of Dr. Loram's results before they were read at Maritzburg, and were benefitted by a comparison of aims and methods.

Those who are familiar with mental tests know of the scale of tests elaborated by Binet, of Paris, some dozen years ago, and later improved by Simon. Goddard, an American, has produced the standard version of them for English-speaking subjects. We have taken the 1911 Goddard revision as our starting point. As in the case of Binet and all his co-workers, we have not tried to secure results of value for comparative psychology of different races, but have kept within the limitations set by our method. Our results, based as they are on relatively few subjects, should not be taken as in the least degree final, but rather as a starting point for more thorough work. I hope to have the privilege of presenting further results in 1918.

The specific aim of the Binet-Simon system of tests is to provide means for the detection of cases of arrested and precocious mental development. It is a means for identifying the various psychological groups, and nothing more. The method consists of giving the subjects questions to ask and problems to solve, which have proved correct for the normal person of each age. The person who solves all the problems set for a child of ten years, and who is unable to do those for a child of eleven, is thus assigned the " mental age " of ten years. If the person is fifteen years old he shows a retardation of five years; if he is nine he shows an advance of one year.

Our material was chosen from the students of the Amanzimtoti Institute and the Adams Practising School, both situated at Adams Mission Station, Natal. Our material ranged from 6.2 to 22 years in age. We chose, out of the 170 pupils at our command, those that appeared to us and their teachers as most typical.

One valid objection to our tests is that the subjects were not living under typical native conditions, but all had more or less influence from European teachers. This we hope to correct by extending our tests to " raw " natives in the future.*

* See *The Pedagogical Seminary*, September, 1917, pp. 373-383, for detailed schedules of our results, for the pictures used, etc.

I shall not recount all the questions and problems used, but run through the list briefly, with various comments.

So far as possible, we have simply translated the tests into Zulu. I shall not here give the Zulu text of every question, nor of many.

The Binet-Simon series of tests begins with tests for "Age 3" and proceeds by steps of a year to "12 years." There are also "15 Years" and "Adult" tests.

Age 3. Here we simply translate three of Binet's tests: "Where is your nose? your mouth? your eyes?" "Repeat 6, 4." "What do you see in this picture?" (pictures of a man on a park bench, a man with a cart, etc.) In place of repeating the sentence used in the Goddard revision, we gave Zulu sentences of an equal number of syllables. In place of asking the family name, we put, "What is your father's name?"

Age 4. We simply translated the tests similar to those translated for Age 3. For one test, in which a key, a knife, and a penny are to be recognised, we substituted three objects more familiar: a mutsha, a native pot, and beads. We tried the Binet objects, but found them too difficult.

Age 5. Here we simply translated the directions, using Binet's tests picking out the heavier object, copying a square, counting pennies, putting together a pattern. We substituted for Binet's sentence to be repeated a Zulu one of the same number of syllables.

Age 6. Here we translated all the tests. For one, where the prettier face was to be selected, we had prepared drawings of native faces, but found Binet's European faces equally satisfactory. For the directions—"take this key from the chair, shut the door," etc., in the tests of obeying commands, we found it wise to substitute a spoon for a key as being more familiar.

Age 7. Here we also translated most of the tests: finding things missing in a picture, such as that of a figure without arms; counting pennies, telling what is seen in pictures, naming colours, copying a rhombus. On the last test (for this age, in which the subject repeats five figures, we had to make an enlarged time allowance of ten seconds instead of three seconds because the Zulu numerals are very long words.

Age 8. Here we had to make some changes. Binet asks for three pairs of differences, which seemed very unfamiliar to the children. We put in such as "What is the difference between *an* ox and a fowl?" On repeating figures we had again to increase the time allowance as for Age 7. For naming the days of the week, which proved impossible for nearly all subjects up to a much later age, we found it good to substitute the naming of seven parts of an ox. The test of making change we had to omit, as being one with objects unfamiliar to most subjects. We did not succeed in finding a substitute.

Age 9. Here we found it necessary to omit all the tests. The test of making change was omitted for reasons just given. The test of defining things—a hand, etc.—had to be omitted, as

in every case the subjects did it no better than those of 6 years, in whose tests this comes. Telling the month and year had to be omitted, as being unknown to most subjects. This is obviously a thing that our more complex life teaches us at an early age. Unfamiliarity made us omit all the other tests: the subjects simply could not understand them.

Age 10. Here likewise we had to omit a test that dealt with coins, since the children did not know more than the penny, half-penny, threepence, sixpence, and shilling. We translated the tests for drawing from memory, and for repeating numbers. In the case of the tests of judgment, we had to make substitutions throughout in order to get material familiar enough to allow of judgment. We inserted such tests as: " What ought one to do when the porridge has boiled over?" " What ought one to do when he has killed a neighbour's goat by accident?" We translated the test on making a sentence from three familiar words, making a change in the words: we used ox, hut, snake.

Age 11. In the tests for discovering nonsense in sentences we had to make a few changes. One sentence has " police " in it in English: we substituted " chief " as being the person of like authority among natives. We found that they knew the police only as tax-collectors. We translated the test for making a sentence with three words, changing it as for age 10. In the test for saying as many words as possible in three minutes, we found it necessary to allow for the slow reaction-time of natives: 35 words in three minutes were all that most subjects could give. The rhyming test we had to omit entirely, as being utterly foreign to the Zulu language. We could not find a substitute. We simply translated the test of arranging words to make a sentence.

Age 12. The test for repeating numbers was simply translated. Children in school at this age seemed able to do it as easily in English as in Zulu. In the test of defining words we found Binet's words unfamiliar: we substituted " love," " brightness," " anger." Binet uses among other words " justice," which was totally unknown. For the sentence to be repeated we substituted a Zulu sentence of the same length, 25 syllables. We simply translated the test for resisting suggestion by picking out the longer line from successive pairs. The last test for this age was very difficult. We found that the problems which Binet used were totally insoluble in most cases. For example, Binet asks " If a man came from the forest and ran to the police, what did he see?" The substitution of " chief " for " police " did not improve matters very much. Most subjects answered, " A snake." It was the same with the case of the lawyer, doctor, and minister calling at a house: the Zulus simply did not know what was meant, since they had never seen such doings at a death. We devised two substitutes: " If you saw a bird's nest, and the mother bird flew in and out again very quickly, and the father bird flew in and out again very quickly, what was the matter?" " There was a dance: somebody went and got the chief to come with his in-

dunas and their sticks; what was the matter?" . These are fairly satisfactory.

Age 15. We used the same pictures as in the 6-year test of like nature, but, as Binet has done, we required an interpretation. This was satisfactory as a test. The time test, of reversing mentally the hands of a clock shown them, and telling what time it would be, proved impossible. Almost every subject was not sufficiently familiar with a clock to meet the test. We substituted a test on the appearance of a footprint when a person has walked backward. While undoubtedly difficult, this new test is practicable, and contains the same mental process as Binet's reversal of clock-hands. The cipher tests to learn the cipher, and, after removal of the paper, to write in it three short words, was excessively difficult. It is an excellent test, however, and might be retained if double value were given for passing it, without double penalty for failure. In giving opposites, we have simply translated the test into Zulu.

Adult Tests.—The test of drawing what a piece of paper folded and cut in a given way appears like when opened was simply translated. All four of the other adult tests were impracticable, since they dealt with matters entirely outside of the subjects' experiences. We have therefore omitted them. The two tests in which differences are asked for are most striking cases in point. Hardly any even knew what a republic was, when asked the difference between a president and a king.

Individual Results.

Our work is based mainly on the following eight individual sets of results. The tests, as given above, were used.

1. V. M. Male, age 6.2. Parents, both Zulu. Father a teacher. Passed all three and four years' tests, and three in 5-years' series. Passed four out of five 6-years' tests. Intelligence age, 5.5. A bright boy in school. This boy counted in English by preference.

2. L. Z. Male, age 10.5. Standard I, Adams' Practising School. Parents both Zulu. Passed all 10 years' tests. Further tests not tried. Passed perfectly a test of 10 analogies; gave 21 words in 3 minutes.

3. W. M. Male, aged 13. Standard I, Adams' Practising School. Parents both Zulu, heathens. Passed all tests through age 10, two out of four in age 11, four out of five in age 12, two out of four in age 15. Intelligence age, 13. This boy began school late. Gave 30 words in 3 minutes. On test with pairs of lines; resisted suggestion.

4. A. N. Female, age 19. Amanzimtoti Institute, School Grade Class, Normal Department. Passed all tests through age 15, and three out of five in adult series. Intelligence age, 18. All tests were given in English at subject's request. Failures in adult tests due to unfamiliarity with material; likewise with hands of clock tests. Unusually quick in reaction time.

5. Z. Mk. Male, age 22. Second Grade Class, Amanzimtoti

Institute, Normal Department. Passed all tests through 12 years. Passed three out of four tests in 15 years. Passed one out of five in adult tests. Sixty-two words given in 3 minutes. All tests were given in English. This student relied far more than any others tested on verbal memory. Rection time was very slow. Gave English and Zulu words mingled in test for gibing words.

7. Tested with translation of regular tests, and not with substitutes. K. Nx. Male, age 14.8. Parents, Zulu. Standard VI, Amanzimtoti Institute. Passed three out of five tests of 12 years, one out of two in 15 years. Twenty-nine words in 3 minutes.

8. Tested as in number 7. L. G. Male, age 14.9. Parents, Zulu. Passed four out of five in 12 years, two out of three in 15 years. Gave definitions "in terms of the question."

General Remarks.

We noted the association-groups in the test of giving words in all cases. They were in all cases many small groups, but not connection between them.

As I have remarked above, the greatest need is to extend the work to uneducated natives. A comparison of the results of such work with work similar to the present report would show what the influence of education is upon the rate, and more especially upon the type of intellectual development.

More extensive tests would show to what extent the current forms of native education are effective as promoters of mental power. Since native education in Natal shows forms ranging from nearly an exact copy of the English schools of 30 years ago to thoroughly modern curricula and methods, there is chance for excellent work of great practical value.

An extension of this work ought to show the truth or falsity of the vulgar assertion that the native mind ceases its growth at puberty. It would demonstrate to what extent education prevents such an occurrence. Our results indicate, so far as they go, that there is no check in mental growth at puberty, but that the direction of growth is not the same as in adolescent Europeans.

To what extent this is a result of the educational systems in use cannot as yet be told. To what extent it is due to different home surroundings must likewise remain as yet undetermined.

The tendency toward pure verbal memory, without association, is noticeable in the subjects examined. This would appear from the data at hand to be a product of education rather than an innate character of the native mind.

It will be noticed that many, if not most, of our changes have had to be made to fit the cultural conditions of the natives. The Binet-Simon tests, as originally devised, seem to test as much cultural conditions as of mental ability. They are based on things and customs not found except in the older and

more advanced countries, and mainly in towns. This must be reckoned with in all work in which they are used. The problems of making change, or rhyming, and the like, are very good cases in point.

I would end with an appeal to extend this sort of work. We lack utterly any criteria as to what is normal progress among natives, and as to the particular directions in which their mental aptitudes lie. With an extensive series of mental tests on natives at hand it will be possible to devize what has hitherto been impossible: a system of education that will fit the natives.

(*Read, July* 3, 1917.)

THE GRASSES OF THE EASTERN COAST BELT AVAILABLE FOR THE MANUFACTURE OF PAPER.

By Charles Frederick Juritz, M.A., D.Sc., F.I.C.

(*Printed in "South African Journal of Industries," January and February,* 1918.)

THE ALLEGED ARREST OF MENTAL DEVELOPMENT IN THE NATIVE.

By Charles Templeman Loram, M.A., LL.B., Ph.D.

(*Printed in "The Education of the South African Native": Longmans, London.*)

Ancient Panama Canals.—The faunal relations of the Atlantic and Pacific Oceans have at various times received the attention of many eminent zoologists and palæontologists. In the course of a series of papers communicated by R. E. Dickerson to the California Academy of Sciences, the author said that recent discoveries and investigations in the miocene, oligocene, and eocene of the Pacific coast had led him to review this subject again. He states some of his conclusions thus: The Panama Portal was closed during cretaceous time, and this gateway was not opened until upper eocene time. During a period of widespread uplift in oligocene time the Antilles were probably connected with Southern Florida, and possibly Central America. Following this emergent stage, a wide submergence occurred during miocene time. At this period North and South America were disconnected, and wide straits in Central America were formed. Since the miocene, the Panama portal has remained closed until the narrow barrier was trenched by the Panama Canal.

EXPERIMENTAL EXPRESSION OF THE RELATIONSHIP BETWEEN THE CONTENT OF A FOODSTUFF IN ANTINEURITIC HORMONE AND THE PERIOD OF HEALTHY SURVIVAL OF ANIMALS UPON IT.

By Henry Hamilton Green, D.Sc., F.C.S.

(*Abstract.*)

(*Printed in Annual Report of the Director of Veterinary Research, Pretoria.*)

An extensive series of experiments upon pigeons is recorded, on diets varying in known fashion in regard to content in vitamine or antineuritic hormone, and an attempt is made to find a simple algebraic expression to explain the data. A formula is tentatively suggested:

$$S = \frac{K}{V - x} \qquad \frac{1}{C}$$

Where S = period elapsing before onset of deficiency disease.

V = minimum proportion of vitamine in the diet necessary for health.

x = proportion of vitamine actually present in the diet.

K = proportion of vitamine reserve in the tissues of the animal.

C = the available energy value of the diet.

It is argued that this tentative expression explains the observations much better than the simple assumption that a fixed daily vitamine intake is required, and gives some indication of the length of time which may be expected to elapse before onset of deficiency symptoms on any given diet is noticeable. It indicates that the quantity of vitamine required for health is not absolute, but depends upon the gross energy value of the diet, and suggests that the function of vitamine is related rather to the gross metabolism than to the structural requirements of the animal. A considerable amount of evidence is adduced in support of this expression, which, though it cannot be relied upon in any one given case, seems to fit fairly well when a large number of individuals is considered, and individual idiosyncrasy is ruled out. Individual variation in vitamine requirements is shown to be great, and this factor renders definite proof exceedingly difficult to obtain. The expression is therefore only provisional, and intended as a guide in the interpretation of conflicting data. It is held that the value for V. is much the same in the avian and in the human subject, but much lower in cattle.

Polished rice, the staple deficient basal diet in the experimental work on beri-beri in the past, is held to be far from "vitamine free," and is regarded as containing residual vitamine equivalent to at least half of average avian or human requirements.

(*Read, July* 5, 1917.)

Seaweed as Fodder.—Analyses of samples of *Fucus vesiculosus*, both in the fresh and in the dried and ground condition, have recently been made with a view to utilisation as stock-food. The following results are recorded:—

	Fresh.	Dry.
Moisture	37.97	11.82
Protein	10.53	6.50
Fat	1.65	3.43
Nitrogen-free extract	26.78	41.93
Fibre	8.95	20.00
Ash	14.13	16.32

The fresh seaweed is richer in protein than the ground dry seaweed, but contains less fat and fibre. Usually seaweed contains but little protein or fat, but a large quantity of nitrogen-free extract and fibre. Recent experiments in Norway, France, and Germany show that food of this class may well be given to animals, and leaves no trace of its smell in either meat or eggs of animals experimented on. The nutritive value of the seaweed appears to depend chiefly on the nitrogen-free extract, which consists principally of lichen-starch, arabinose, *d*-galactose, etc. The fibre is probably also easily digested. It seems most advisable to give the seawood in the ground dry state, as a supplementary food, especially to cattle and pigs, but its nutritive value must not be overrated.

Early Man in America.—E. S. Balch, in a paper read before the American Philosophical Society,* summarises the present status of knowledge about early man in America. He believes that early man was there; that he lived during at least part of the Pleistocene period for tens of thousands of years south of the Glacial moraines; that he probably went through an eolithic period, and certainly through a Chelléen period in some places, and therefore was truly a Palæolithic man. Palæolithic American man was the ancestor of the Neolithic historic Indian, and, although less advanced in culture, much like his descendant in anthropological characteristics.

* *Proc. Amer. Phil. Soc.* (1917), **56**, [6], 473-483.

FOMES APPLANATUS (PERS.) WALLR. IN SOUTH AFRICA, AND ITS EFFECT ON THE WOOD OF BLACK IRONWOOD TREES (*OLEA LAURIFOLIA*).

By Paul Andries van der Bijl, M.A., D.Sc., F.L.S.

(*Plates* 14-17, *and two text figures.*)

Introduction.

The fungus *Fomes applanatus* (Pers.) Wallr. is about the commonest of the Polyporaceæ occurring in South Africa, and is perhaps better known under the name *Fomes australis* Fr. There is, however, no specific distinction between the above two fungi, and many of our specimens agree exactly with *Fomes applanatus* as known from Europe and America.

Lloyd* writes: "In a narrow sense this (*F. australis*) is a tropical form of *Fomes applanatus* with a thin context and long pores." "It is a time-honoured custom to refer every *Fomes* of the section *Canodermus* that came from the tropics to *F. australis*." And again†: "In the tropics *Fomes applanatus* often takes a form exactly the same as the European form, but generally the crust is hard and brown, and then it is classed as *Fomes australis*."

Murrill‡ places this fungus in his *genus Elfvingia*, and cites *Fomes australis* as a synonym of his *Elfvingia tornata* (Pers.) Mur.

Heald§ describes *Elfvingia megaloma* (Lev.) Mur. as causing a disease of cotton-wood, and cites *Fomes leucophæus* (Mont.) as a synonym.

Fomes leucophæus can, however, hardly be regarded as a distinct species, and the only difference between it and *F. applanatus* is that in the former the crust is of a lighter colour.

Under the name *Fomes australis*, Petch|| mentions this fungus from Ceylon on palms and bamboos as well as on dicotyledonous trees, and states that whereas it is usually saprophytic, several instances had been noticed in which it began to grow on the exposed surface of a wound, and from that starting-point proceeded to destroy the tree. This was observed on a large *Zizyphus Xylopyrus in the Peradeniya* Botanic Gardens. As far as *Acacia decurrens* (cultivated wattle) is concerned, he writes:

Only the old trees at Hakgala are known to have been attacked, but it is evident from an examination of the stumps that most of the Acacias

* Lloyd, C. G., "Synopsis of the Genus *Fomes*." 265.

† Lloyd, C. G., *ibid.*, 264.

‡ Murrill, Wm. A., "North American Flora," **9** [2], 115.

§ Heald, F. D., "A Disease of Cottonwood due to *Elfvingia megaloma*," Nebraska Agric. Expt. Stn., Nineteenth Ann. Report, 92.

|| Petch, T., Circulars and *Agric. Journ. of the Royal Botanic Garden, Peradeniya*, **5** [10], 92.

which have died there have been killed by *Fomes australis*. The progress of the disease is apparently very slow, and it must have been at work on these trees for many years.

Von Schrenk and Spaulding,* referring to the disease in cotton-wood caused by *Fomes applanatus*, write:

> The writers have repeatedly observed this form of decay in the cotton, but in their experience it usually starts near the base of the trunk in large wounds caused by fire or otherwise. On that account they are not inclined to call this decay of the cottonwood a disease in the sense in which the decays induced by *Fomes ingniarius*, *F. fraxinophilus*, and others, are diseases. There are a large number of species of fungi which, like *Fomes applanatus*, grow on dead wood, and which may now and then grow on living trees. All of these, including *Fomes applanatus*, can grow just as well, and apparently better, on wood after it has been cut from living trees, and should, in the opinion of the writers, be considered as saprophytic forms.

The above view is rather to the extreme, and even if it holds for the cotton-wood disease in America, it certainly does not for black ironwood in South Africa, which latter is more in agreement with the observation on *Acacia decurrens* (the wattle) by Petch in Ceylon. We must bear in mind that there is no sharp line of demarcation between parasitic and saprophytic fungi. As an extreme case of parasitism, we may take the fungus *Fomes rimosus* Berk., which grows only on living trees, and when it has killed its host ceases itself to grow. As extreme cases of saprophytism, we have the fungi which live and grow only on dead organic plant and animal remains. Between these two extremes we have: (1) Fungi which start life as parasites, and continue to grow and thrive on their dead hosts—they become saprophytic; (2) fungi which start life as saprophytes—*e.g.*, in a wound, etc.—and then grow into the healthy tissue of their hosts, which may ultimately succumb.

It is in this latter category that we must place *Fomes applanatus*, which, even if it does start as a saprophyte, is nevertheless capable of invading living tissues of its host, and is frequently the main cause of the death of trees which it has attacked. Having killed its host, it continues to grow and thrive on the dead remains—it returns once again to a saprophytic life.

The cycle of this fungus is from saprophyte to parasite and back again to saprophyte, though the parasitic stage is not necessarily essential to the life of the fungus, and is often omitted. *Fomes applanatus*, in other words, is a *facultative parasite*.

Hosts of *Fomes applanatus* in South Africa.

This fungus has been found on a large number of different trees in South Africa, as the following list indicates. In some instances the host was dead at the time the fructifications appeared, whereas in others the host was still alive: *Olea foveolata* (bastard ironwood); on dead and also at the base of live

* Schrenk Hermann von, and P. Spaulding, "Diseases of Deciduous Forest Trees," U.S.A. Dep. Agric., Bureau of Plant Industry, Bull. 149, p. 58.

trees of *Olea laurifolia* (black ironwood); on stumps of *Acacia molissima* (cultivated wattle); *Melia Azedarach* (Syringa); on dead and also on live *Rhus lævigata* (red currant); *Curtisia faginea* (assegai wood); on dead and also in wounds of *Trichocladus* sp. (underbush); bole of dead but standing *Podocarpus* sp. (yellow wood); in wound of live *Pyrus communis* (cultivated pear); *Celtis Kraussiana* (Camdeboo stinkwood); dead log of *Scolopia Mundii* (red pear). Many specimens have been entered up as growing on dead logs, which were not possible to name, and the above list will later probably have to be considerably enlarged.

THE FUNGUS ON BLACK IRONWOOD (*Olea laurifolia*).

Sim,* treating of *Olea laurifolia*, writes:

> Trees which appear quite sound outwardly are often found to be more or less decayed inside, even without showing much evidence of that in the cross-cut, but the sound parts of such a tree are not rendered unfit thereby.

The above is the only reference to a decay of black ironwood trees in South Africa, and whether Sim had this fungus or *Fomes rimosus*, which less frequently may occur on the same host, in view, I do not know.

The loss of black ironwood trees owing to attack by this fungus must be considerable, as I had an opportunity of seeing for myself when, in 1915, in company with Mr. J. D. Keet, of the Forestry Department, I visited several of the forests of the Eastern Conservancy.

As a result of the decay induced by this fungus the trees are weakened, and are easily blown over by the wind. Frequently the sporophores of the fungus develop only after the tree has been blown over, but they have also been observed at the base of live black ironwood trees, and there can be on doubt about this fungus being directly responsible for the decay and ultimate blowing over and death of these trees.

The fungus in most cases probably gains entrance through small wounds or abrasions near the soil level, a place which, since it is usually somewhat moist, would favour the development and growth of external mycelia of the fungus. The trees affected are invariably full-grown, though it can hardly be held that their vitality had become impaired prior to infection by the fungus. Furthermore, in no case observed in black ironwood was there any large wound, such as von Schrenk and Spaulding would appear invariably to associate with the cotton-wood disease. The attacked part is soft and punky, and the decayed wood in the dry condition is readily crumbled between the fingers. We come next to consider the action of the fungus on the wood. Figure 1 illustrates a transverse section, which had been treated with chlorozinc iodide. The lamellæ bordering the lumina readily take the cellulose

* Sim, T. R., "The Forests and Forest Flora of Cape Colony," p. 265.

stain with the above reagent, and this region is dotted in the illustration. After conversion of the lignin into cellulose the cellulose is digested by enzymes secreted by the fungus, and this is evident from the cellulose ridges which project into the lumina. The cell walls become thinner and thinner as a result of delignification and digestion of the cellulose, and ultimately, when completely absorbed, the cavities formed become filled with fungoid tissue.

I have not seen such large masses of fungoid tissue as is frequently met with in trees attacked by *Fomes rimosus* Berk., but thinner, more or less felt-like fungoid tissue is easily evident when diseased wood is split lengthwise. Plate 15 *a*, is a photograph of a piece of wood of black ironwood in which delignification has already taken place to a considerable extent. Though enzymes were not specially tested for there can nevertheless be little doubt that both delignification and the digestion

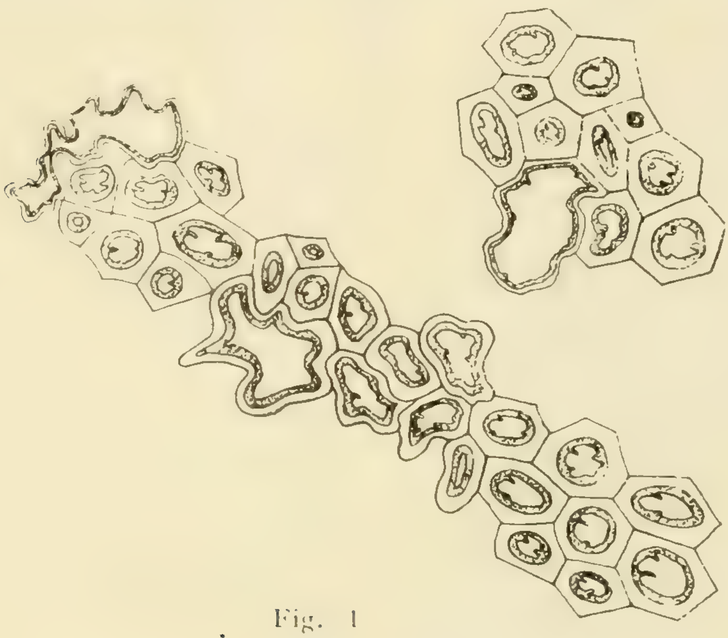
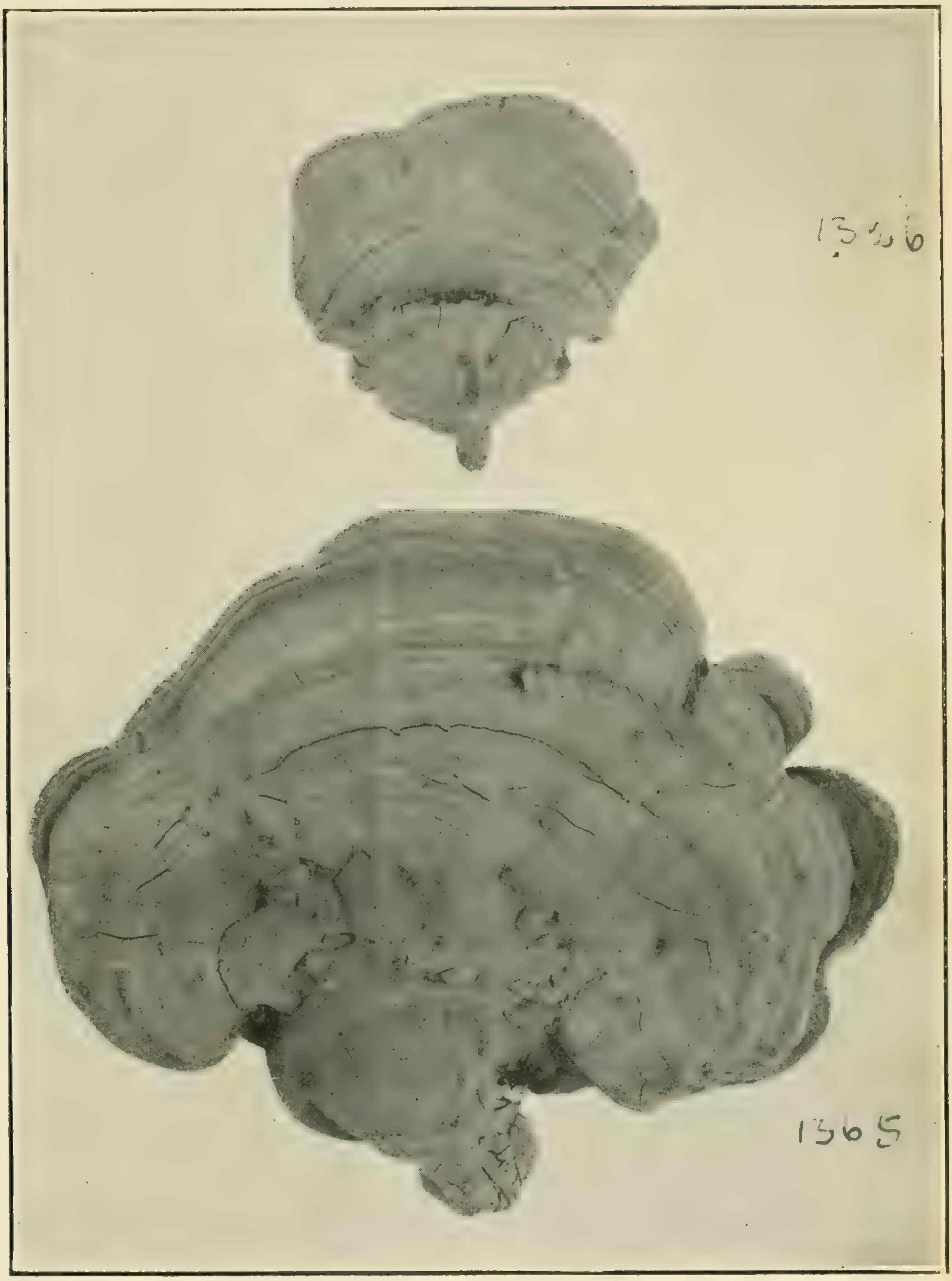


Fig. 1

of the resulting cellulose is caused by enzymes secreted by the fungus.

The mycelium of the fungus, as seen highly magnified in the wood and illustrated in Fig. 2, is composed of hyaline, branched and septate hyphæ, which measure 1.2 to 1.6 μ and less, (frequently 2.8 μ, in diameter, and are frequently decidedly vacuolate, as shown in the drawing. For staining the mycelium in the host I employed methyl violet after first mordanting the sections in tannic acid, and this method gave very satisfactory preparations. Fig. 2 also shows the hyphæ of the fungus passing through the pits of the wood, and I have not observed the fungus to bore its way directly through the cell walls. For the hyphæ to get from cell to cell the presence of the pits in the cell walls would appear to be essential.

A yellowish deposit has been observed in the lumina of the vessels, raycells, etc. These deposits are of frequent occurrence in the wood of trees attacked by pore fungi, and some



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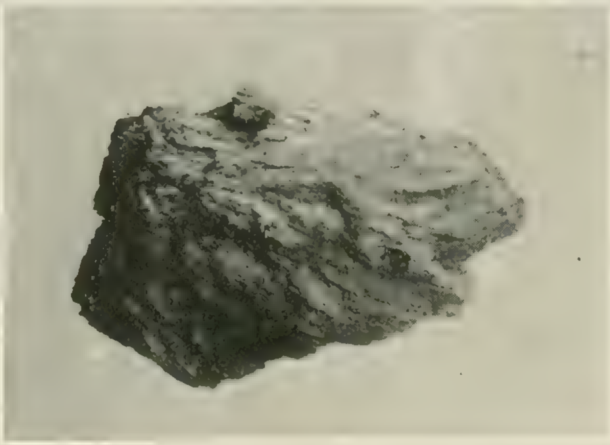

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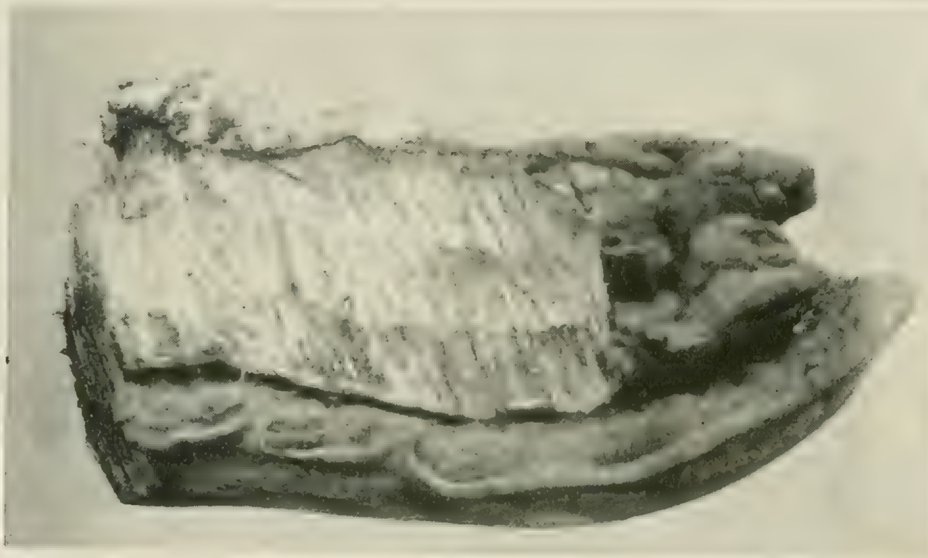

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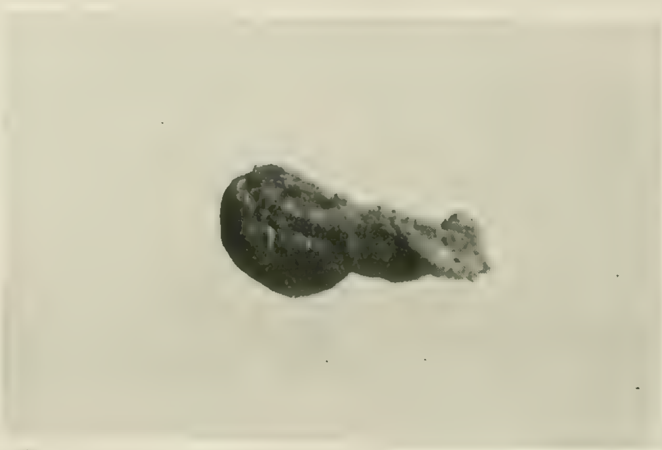


C

P. A. Van der Bijl.—*Fomes applanatus.*

authors have suggested that the tree endeavours to check the advance of the fungus by plugging its cells with deposits which fill their lumina, and are very difficult for the fungus to pass. The chemical nature of the deposit I have not investigated, but it appears to be difficultly soluble.

Description of the Fungus.

The bracket-like body which grows out from diseased or dead trees is the fructification—*sporophore* or *pileus*—of the fungus, and the spores of the fungus are borne in the minute pores, which are evident on the lower surface of the sporophore. The following is a description of the sporophore, and with the aid of the photographs it is hoped the fungus will be readily recognized.

Pileus, Plate 14 and Plate 15 *b*, perennial, hard, woody, dimidiate, sessile, thin and applanate, though less frequently

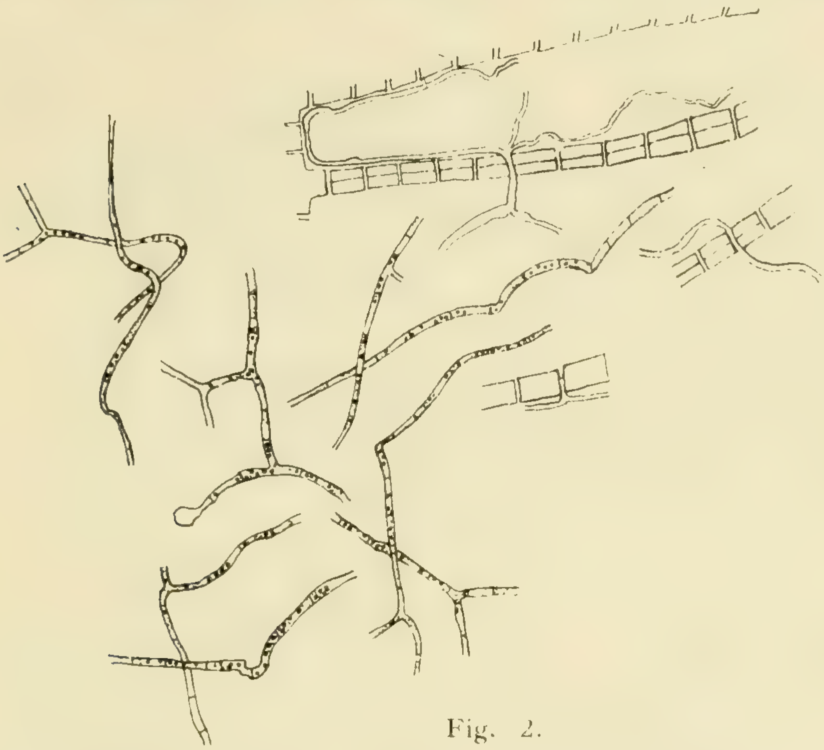


Fig. 2.

ungulate and thick, plane below or somewhat hollowed or concave; often very large, 10.5 to 42.5 × 10-23 × 2-10 cms. Surface covered with a thick, horny, encrusted layer, greyish, reddish or drab-brown, zonate or concentrically sulcate, glabrous or somewhat tuberculose, opaque to subshining, conidial bearing. Margin smooth, thick or thin, sterile, acute or obtuse, and at times truncate. Context dark bay brown, floccose to soft corky, 2-9 mm. thick. Tubes stratified, .5-2 cms. long each season; old tubes stuffed with white fibrous fungoid threads, between which are the dark amber of their walls (Plate 15 *b*). Strata of pores in many specimens separated by context tissue (*Fomes vegetus* Fries.),* in others not thus separated. Mouths

* *Fomes vegetus* Fries. is described as having the pore layers separated by context tissue, but this is, as pointed out by Lloyd, a condition of *F. applanatus*, and not a distinct species.

minute, 3-4 to mm., circular, white to dark umber, darken when bruised. Spores (Plate 16 *c*) ellipsoid, truncate, yellowish-brown, with thick walls, which are either smooth or punctate and roughly echinulate, 6.6-8.25 $\times$ 8.25-9.9 μ diameter. The spore is surrounded by a hyaline membrane, and it is the collapse of this membrane at the base which gives the spore its truncate appearance.

Plate 17 *a*, illustrates some young sporophores. They first appear as white, corky nodules, which under favourable conditions develop into the horizontal bracket-shaped sporophore, and under unfavourable conditions turn hard and brown. For how long it is capable of remaining in this condition, and yet retain its power of further development on the return of favourable conditions, I do not know.

Plate 17 *b*, is a photograph of a fungus in Mr. Pole Evan's herbarium (No. 1703), and which I named *Polyporus gibbosus* Nees. In surface, pores, context, colour, and spores it agrees with *Fomes applanatus*, and differs only in the lateral stipe. Lloyd* recognizing this resemblance, writes: "It (*Polyporus gibbosus* Nees) could be considered, of course, an annual stipitate form of *Fomes leucophæus*, but in the United States, where *Fomes leucophæus* is the most common species we have; it never takes a normal stipitate form. Sometimes *Fomes leucophæus* takes a false stipe when growing under abnormal conditions, but I believe that the stipe of *Polyporus gibbosus* is a normal feature of the plant."

Plates 15 *c*, and 17 *c* are stipitate forms of *Fomes applanatus*, and these forms I have thus far observed in South Africa only growing at about soil level, and usually in the rotten cavities, and partly covered by *débris*, etc. All stipitate forms I have thus far seen have been annual.

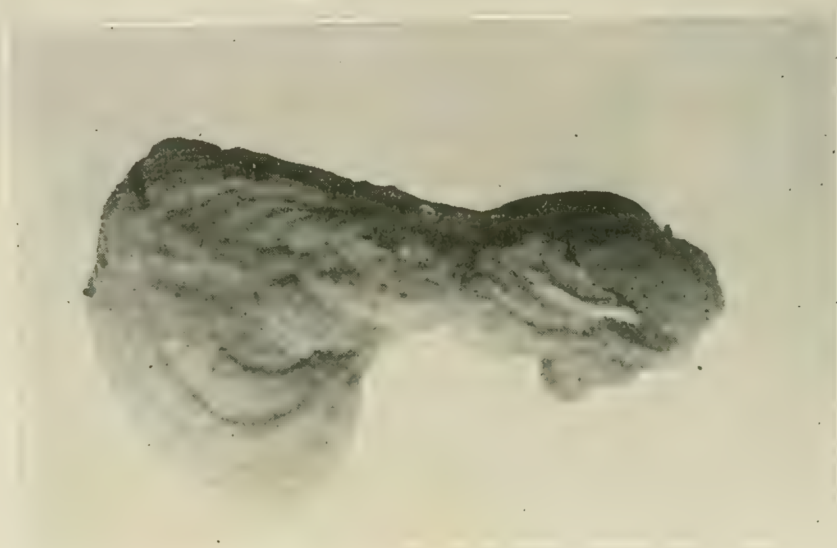
It is of necessity difficult to come to any conclusion as to the real position of *Polyporus gibbosus* Nees, but its relationships are evidently so close to *Fomes applanatus* that I am inclined to think that when the original specimen of Nees is examined, it will turn out to be but a form of the latter fungus.

In the Mycological Herbarium of Mr. I. B. Pole Evans there is a specimen (No. 2338) with amber yellow pore mouths, and this I named *Fomes oroflavus* (Lloyd, "Syn. Fomes," p. 265). Except in the colour of the pore mouths, and that the spores are slightly larger, it further agrees with *Fomes applanatus*. Lloyd† regards this fungus as a tropical form of *Fomes applanatus*, and writes further: "A quite frequent plant in the tropics, otherwise the same (as *F. applanatus*), has deep yellow pore mouths. We have never seen but one specimen from Europe that approximates this tropical form. We have several collections from the United States (particularly California), which we refer to *Fomes applanatus* (and rarely to *Fomes leucophæus*), that have yellow pore mouths, but they

* Lloyd, C. G., Letter No. 55, p. 3.
† Lloyd, C. G., *op. cit.*, 265.

P. A. VAN DER BIJL.—*FOMES APPLANATUS*

A



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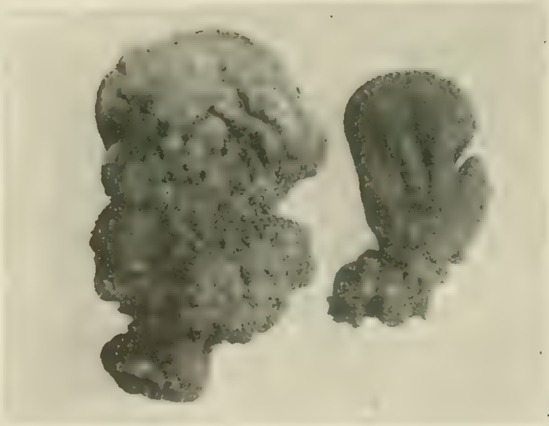


C

P. A. Van der Bijl—*Fomes applanatus.*

are not the deep yellow of the tropical plant." The above is the only specimen with yellow pore mouths that has come to my notice, and was collected in the Knysna forests by Mr. P. J. Pienaar, on *Podocarpus Thunbergli,* a host on which the typical *Fomes applanatus* also occurs.

Suggestions for Control.

Methods of control should follow preventative lines. The practice of leaving in forests fallen trees and stumps infected with this fungus, and on which the fruiting bodies of the fungus frequently develop in great abundance, is not only opposed to proper forest hygiene, but it is a sure means of propagating the fungus, and enabling it to maintain itself in the forests. This practice, therefore, continually exposes the trees to infection when a favourable opportunity offers itself.

Dead stumps and trees killed by the fungus should be destroyed by fire, and all sporophores collected and similarly destroyed. Depending somewhat on how infection has taken place, it will be possible in certain instances to preserve the tree by cutting out the developing sporophore and diseased wood and painting the wound thus formed with tar. This method would be found useful, especially where it is desired to preserve attacked ornamental or shade trees, but in a large forest it is hardly practicable, and here all attention should be directed to prevent infection taking place. This can only be accomplished by the destruction of the sporophores of the fungus, and since the fungus fruits very readily on the dead remains of the tree it has killed, all infected material should be destroyed as well, and attention given to proper forest sanitation.

Summary.

The paper treats of *Fomes applanatus,* a fungus very common in South Africa, and particularly deserving of attention as it is the main cause of the death and blowing over of large numbers of *Olea laurifolia* (black ironwood) trees in the Eastern Cape Conservancy. The fungus further occurs on a large number of other hosts, and the list will probably later become considerably enlarged.

On black ironwood the fungus is regarded by the author as a *facultative parasite,* which gains entrance through wounds at about soil level, and from here grows into the healthy wood and starts its work of destruction. The fungus continues to form sporophores after it has killed its host, and this is a point to be remembered in methods of control.

The action of the fungus on the wood is described as one of delignification followed by digestion, and agrees with the observations of Heald, as also with the effect of the fungus *Polyporus lucidus* Leys.* on willow, as pointed out by the present writer. A description of the fungus is given, and attention

* "Note on *Polyporus lucidus* Leys., and its Effect on the Wood of the Willow," Rept. S.A. Assoc. for Adv. of Science (1916), Maritzburg, 506.

also drawn to forms of the same fungus, which occur in South Africa.

Methods of control should follow preventative lines, which are best attained by proper forest sanitation, such as the destruction of sporophores of the fungus and of diseased wood.

Acknowledgments.

My thanks are due to Mr. I. B. Pole Evans, Chief of the Division of Botany, for placing certain references at my disposal, and also for allowing me to examine some material in his herbarium.

I also acknowledge the assistance given by various officers of the Forestry Department, and especially Mr. J. D. Keet in collecting specimens of this as well as other Polyporaceæ, as also for notes which frequently accompanied the specimens.

Some specimens of this fungus were verified by Mr. C. G. Lloyd, of Ohio, and him I thank for assistance with the Polyporaceæ generally.

The drawings were kindly made for me by Miss K. A. Lansdell, of this Department (Natal Herbarium, Durban).

Explanation of Illustrations.

Fig. 1.—Highly magnified transverse section through black ironwood to show the delignification and digestion of the wood brought about by this fungus. The dotted regions gave reactions for cellulose with chlorozinc iodide, and the digestion is evident from the cellulose plates projecting into the lumina.

Fig. 2.—Section highly magnified, and showing the mycelium of the fungus in the wood of black ironwood, and passing from cell to cell through the pits in the cell walls.

Plate 14.—Photographs of sporophores of *Fomes applanatus* from stumps of *Acacia mollisima*. The specimens are in the herbarium of the Government Mycologist at Pretoria, and the numbers are those of that herbarium.

Plate 15 *a*.—Photograph of wood of diseased black ironwood, which has already been considerably delignified, and crumbled easily between the fingers.

Plate 15 *b*.—Sporophore of *Fomes applanatus* from dead *Podocarpus* sp.

Plate 15 *c*.—Abnormal laterally stalked form of *Fomes applanatus* from *Olea laurifolia* (black ironwood).

Plate 16.—Spores of *Fomes applanatus*. Highly magnified.

Plate 17 *a*.—Nodules of *Fomes applanatus*, which develop into the bracket-shaped sporophore.

Plate 17 *b*.—*Polyporus gibbosus* Nees. No. 1703 from Herbarium of Government Mycologist, Pretoria. This fungus is most probably only a form of *Fomes applanatus*.

Plate 17 *c*.—Abnormal laterally stalked form of *Fomes applanatus* from dead *Rhus lævigata* (red currant).

(*Read, July* 3, 1917.)

SOME FACTORS IN THE REPLACEMENT OF THE ANCIENT EAST AFRICAN FOREST BY WOODED PASTURE LAND.

By Charles Francis Massy Swynnerton, F.L.S., F.E.S., F.R.H.S.

1. Introductory.

The observations of which this paper is an incomplete *résumé*, general at first, but more detailed since early 1913, when an investigation of Mr. A. K. Thayer's views on the all-concealing properties of forest led me to some close semi-œcological work and thus to an interest in œcology itself, have extended in all over eighteen years during which I have lived near forest patches. For the last sixteen of them I have lived right on the outskirts of the largest piece of high forest in Southern Rhodesia—Chirinda—and I am including here a brief account of the results of a private attempt of my own at forest protection that has led to a reversal of the process described in the title.

I have not seen this type of forest, as it occurs in East Africa, discussed at all thoroughly—though it very likely often has been, for I have no access to libraries, and my own is very limited.* It is impossible, actually, that the idea of its former continuity should not have occurred to everyone in the least acquainted with the distribution of our forest plants and animals, and it is the evidence afforded by their distribution that still gives the idea its best support. It may be of interest, nevertheless, if I state the evidence of other kinds, in so far as I have observed it, that a single locality can produce, and discuss the main factors that may have affected the distribution and welfare both of this type of forest and of its supplanter.

My observations have been confined to the Melsetter district of Southern Rhodesia, and to the foot-hills and lowlands in Portuguese East Africa that divide that district from the sea; and it is to this small section of our East African floral area that my remarks and conclusions primarily apply. I cannot help feeling that their applicability is, actually, wider, though I do not for an instant flatter myself with the belief that my local and still incomplete observations have given me all the factors that will have contributed to the change referred to in the title of this paper, or even, quite necessarily, the most important of them; and my object in writing is rather to provoke discussion

* I cannot tender this excuse for having overlooked Mr. J. S. Henkel's most interesting account of "Forest Progress in the Drakensberg" until the very day before posting the present paper. It is pleasing to have been able to confirm his observations from another portion of the sub-region. I am sorry I have not seen Prof. Bews's paper referred to by Mr. Henkel, or any other references to the subject, so far as I remember, excepting those actually alluded to in this paper. I hope that this will be accepted as an excuse for any resultant shortcomings.

and the production of evidence from elsewhere than in any way to attempt to dogmatize.

2. The Two Types of Wooding referred to.

From where I write, 700 feet above the nearer flats, and 4,000 above sea-level, on the hill that is crowned by Chirinda, I can see an immense tract of country. It includes low veld, stretching away to sea-level and looking like the sea, foot-hills, plateau, and high mountains, the latter with peaks of nearly 9,000 feet. And practically the whole of this great stretch of country, physically and geologically most varied, is to-day under grass, and to the greater part of it can be accurately applied Welwitsch's term of "wooded pasture." The wooding varies from widely-scattered shrubs and small trees and groves to a uniform covering of close-standing trees that is nevertheless mere wooded pasture, not true forest. The species are extraordinarily varied, but nearly pure wooding sometimes occurs in the groves of *Uapaca Kirkiana* and *Brachystegia* on the drier slopes of the mesophytic areas, of *Acacia* near *natalitia* on the dolerite, and of *Copaifera mopane* in areas of smaller rainfall. Grass fires, lit by natives wishful to cultivate, or hunting buck and rats—also nowadays by whites—sweep over it annually.

The type of vegetation is one which, with variations, is common through much of Africa south and north-east of Tanganyika.

One feature in the view remains unmentioned. In rare, isolated, little patches on the flats, or filling kloofs, or, more frequently, crowning hills and looking like the "Rings" on the Sussex downs, are small, dark "forests of gigantic timber," as Livingstone called them in Angola. The nearest of them, a hundred yards away, completes the panoramic view I have described, carrying it round from the south-east to the west again, and, except for its larger size, is sufficiently typical of them all. Its suddenness—its non-blending with the surrounding grass veld—is the feature that most strikes an observer outside. It is like a tall plantation. On entering it, one is struck with its loftiness, its density, and its step-like formation, described already in my paper on the Melsetter trees and shrubs. No contrast could be stronger than that between this type of forest and the wooding of the grass veld, whether we have regard to their outward appearance or to more fundamental characteristics. The trees of the forest are intolerant of fire, the pasture trees are especially adapted to withstand it. The members of the one formation never enter into competition with those of the other—where grass-burning is the practice—yet the soil and moisture conditions inside and outside the forest are exactly the same, excepting in so far as they are modified by the presence of the forest itself.

Sub-divisible, as the effect of altitude, into "mountain" and lowland types, the first with an admixture of Gymnosperms, the second without them but loftier, and varied further with latitude, Chirinda-like forest is found in patches throughout East Africa

from the Cape Province to Elgon and beyond, in the higher rainfall areas; but in parts of the Congo basin and elsewhere in the west it covers the face of the country. A suggestive gradation occurs from this condition, through the forests of British East Africa, which, if isolated, are still large, down to the diminutive dense forests of Southern Rhodesia. Where continuous they are regarded, I believe, as primary. Are they then to be looked on as secondary in the other areas? If so, how, with such laboriously-moving constituent members as, for instance, *Widdringtonia*, have they reached their present widely isolated positions? If not, why are they no longer continuous throughout? It is the last problem, chiefly, which I propose to discuss in this paper.

3. Present Distribution of High Forest in the Melsetter-Beira Section.

Chirinda is our largest patch on the British side of the border, but, as I have said, it is by no means the only high forest in the country. Small patches are scattered along the Portuguese border and in Portuguese territory south of the Lusitu River, and wooded kloofs often tend to reproduce this type of forest. Further north, the higher mountains, including Chimanimani, boast many forest patches of the "mountain" type, and forest patches crop out along the high Anglo-Portuguese boundary so far north as Umtali and, I am told, beyond. I am not acquainted with the last-named patches, but Mr. L. Cripps told me, when in Chirinda some years ago, that he recognised there species of big trees which also occur in forest on his farm near Umtali. I am not aware that forest of this kind occurs much more than 25 miles west of the border, and, if that be the case, it may be regarded as falling entirely within the area of greater rainfall; but, travelling 30 or 40 miles east, one comes on an extensive forest patch, larger than Chirinda, on the eastern slope of the Sitatonga Hills,* and, far nearer sea-level and relatively nearer the coast, the well-known patches on the Beira Railway and one south of the Buzi River which contains, as well as *Khaya nyasica*, other trees that in growth, foliage and bark I was unable to distinguish from certain trees of Chirinda, though I was unfortunately unable to secure flowers. It is true that further dense forests—the great dwarf rubber forests of the lower veld—cover immense areas, and may well be taken into consideration in connection with the distribution of our forest animals (they are the only place in which I have seen *Papilio ophidocephalus*, also occurring in Chirinda, really abundant, but they seem to me to belong to a very different type from the kind of forest I am discussing here, and probably to be, in part, secondary. At the same time, I am informed that in portions of these forests not visited by myself

* I include the Sitatonga Forest with a slight reservation. I passed through in May, 1900, when I had not yet taken up botany, and when, also, I had not yet seen Chirinda, so that my memory of it may be inaccurate. I believe it to be correctly included here.

(*e.g.*, at Makupi's), patches of Chirinda-like forest occur, and I judge from the statements of natives that other patches of the same kind must occur here and there in the low veld off the beaten tracks.

4. Evidence of Forest Destruction and Probable Former Continuity.

(1) *From more or less direct observation.* I have myself seen a single fire destroy a 10-15 yards depth of forest along a very limited front, and, in the Chimanimani Mountains, seen where much larger areas than this had been cleared by the last season's fire; and I have witnessed in the eighteen years I have resided here a more gradual, yet definite, eating into portions of the outskirts of small forest patches with which I am acquainted, by the annual fires. The evidence of old natives in this connection—at any rate of those who do not live right up beside forest —is apt to be unsatisfactory, as they appear not to observe and remember readily gradual events that concern them little; but one very old man—old even when I first came here—who lived in his youth right beside the Chipungambira patch (near Spungabera), and then moved up beside Chipete, tells me that when he was a lad some specially destructive fires destroyed quite large pieces of each of these forest patches.

In the case of the "Jihu"—a large, rich, mostly Portuguese trap-area south of Chirinda—it is possible that 30 or 50 years hence no one will be able to say from personal observation that true forest ever existed there. Yet in 1906 evidence, in the form of charred tree-bases, the vegetation that immediately succeeds forest, etc., still pointed unmistakably to the recent existence of a good-sized patch on the eastern slope of the rise dividing the Zona and Kurumadzi rivers, and, near the Zona, a patch of fine mahoganies still stood, but some of their late companions were sprawling, charred, on the ground just round them, and were surrounded in turn by the evidences of previous destruction.

As for the matter of former continuity it is suggestive that the final destruction of the first-mentioned forest-patch widened by several miles the gap between surviving patches, while the piece of Chipete said to have been destroyed 60 years or so ago continued that forest towards a still-existing outlying strip of Chirinda.

2. *Indirect Evidence.*—The *position* of the majority of the surviving patches is perhaps suggestive. Three of six patches I can see from where I write definitely crown hills, and two others are on a ridge. This very common position certainly *seems* to point to the probability that fires sweeping from below have gradually eaten up the forest lands till these for the most part occupied only the hills, and have then burned across the "neks," split the forest stretches into patches, each occupying the higher parts of a hill, and then continued to eat these

back by the process already noted. Compare, also, Whyte's description below.

Not that their elevated position is, by any means, all there is in favour of the hill-tops as a last refuge of forest. Sandstone and shale below, they are frequently capped with overlying dolerite and the fertile red loam that belongs to it, and that seems to offer this type of forest the best guarantee of the luscious margin, even in the dry season, which helps it to keep out fire. At the same time, these dolerite caps are in several cases a continuous part of the main masses of our two big trap-areas—are, so to speak, the very slightly outstretched processes of a great *Amœba*—and it is therefore highly suggestive of the first view here mentioned, that it is chiefly these, the culminating points, and not the main masses, that to-day carry forest. Chirinda, Chipete and Maruma are amongst the examples. Again, some of the higher mountain-forests, and considerable slices of Chirinda itself, as well as small patches elsewhere, and some experimental planting of my own, show clearly that this type of forest can flourish perfectly well on the sandstone and shale, although, for indirect reasons, such as the one I have suggested, it has undoubtedly, I think, been the general tendency for the fires to remove it from these areas first.

The *plants and animals* of the forest-patches afford evidence of the usual kind. One has to be cautious in relation to the alternative possibility of migration, and a bird like the Milanji Bulbul (*Phyllastrephus milanjensis*), which inhabits also the wooded kloofs, is under suspicion of having travelled along by easy stages; but it seems significant that trees with no special means of seed-dispersal are found in very widely-separated patches unconnected by water, and that the same applies to animals that, at any rate, one does not suspect even of local migration. Such are the common Robin of Chirinda (*Erithacus Swynnertoni*), formerly found only there and in Chipete, but since discovered by Mr. P. A. Sheppard in forest-patches near Macequece, on the Beira railway, and such shade-loving and unenterprising fliers as the butterflies *Aterica galene* and *Euphœdra neophron*, taken by me in the Sitatonga and Chirinda forests, and seen in others. However, the resemblance between their arthropod inhabitants generally is striking, and one finds such utterly sluggish species as the scarlet millipede of the tree-trunks (*Spirolobus*), and a barely-moving "red spider" (*Trombidium*) in widely-separated patches. Cases like these last seem to me to tell decisively against the theory of migration.

The usual *succession of vegetation* that follows forest also affords good evidence of progressive shrinkage and probable former continuity, and the case of *Chipete* is instructive in this and in other ways. It is a patch of perhaps 40 acres crowning a hill, and separated now from the main body of Chirinda by a wide kloof and several hundred yards of grassy hillside. There is a little wooding in the kloof, and there are three diminutive scraps of it near its head, on the Chipete side, on the sandstone.

That these are not purely new growth, but originally, probably, the remnant of a former general continuity between Chipete and Chirinda is suggested by the presence till, some years ago, of a couple of old decayed trees, by the fact that the destruction of the little patches (in no way worth protecting) has gone on till nearly nothing is left of them but a few square yards of rank green grass and creepers in each place, and by an examination of the surrounding vegetation with the usual local succession in mind. This last suggests the former connection of the three as a single, straight strip of forest, and the latter's yet earlier connection with a Chipete far larger than at present.

An examination of the low, erect, so-called "*Sand-apple*" scrub (*Parinarium curatellæfolium*), which nearly everywhere clothes these hills, bears all this out, and indicates further facts, in a very remarkable way. For, whatever agency—their own once more abundant parents or some animal that distributed the stones—once sowed these little sand-apples broadcast and ubiquitous over the face of the country, has obviously ceased to exist many years ago. Now the sand-apple will just germinate in forest, but it won't live there; so that those areas that were covered with forest at the time the sowing ceased should to-day show no sand-apples. Actually, a most clearly defined bare ring of this kind surrounds Chipete, and others surround Chirinda itself (with much country to its south-west), the group of three little patches referred to above, a piece of ground between these and the former, big Chipete, and—a further link, taking us to within 200 yards of Chirinda—a long, narrow piece of ground with occasional suggestive vegetation between these same little patches and the latter forest. I may say at once that neither differences in the soil, or in its humus or water-contents, nor any other factor except the one I suggest, has proved at all capable of accounting for the sharp demarcation, in these places, between the ground that is crammed with *Parinarium* and that which has none.

In general, the "Sand-apple line" seems to show that the main body of Chipete at the time indicated swept down far nearer to Chirinda than it does at present. It also (contrary to expectation based on the lie of the ground) suggests that the fires worked in between the forests from the *head* of the kloof, along the broad sandstone area that still carries the disappearing connecting-links I have described, and that the latest point of junction between the two forests was at the point indicated by the information received from the old Kaffir, along a ridge characterized by dolerite. This illustrates the fact already referred to, that forest tends to disappear from sandstone first. Further, if the latest point of junction was actually at the spot suggested, Chipete would have formed a *fold* of Chirinda, and its native name, meaning "the fold," would perhaps be explained. Natives questioned as to its origin have always said they do not know—that the name was handed down to them by their forefathers.

A similarity in the species comprising Chipete and the part of Chirinda that was, apparently, last connected with it is suggestive, but not conclusive, for bird-carried species are largely concerned.

To sum up: Chirinda itself, shaped like an hour-glass by the fires that formerly ran in between its twin heights, shows us an early step in forest-splitting. Chipete, only a few hundred yards away, and with highly-suggestive evidence of a former continuity with Chirinda, the next. The other patches of the country show us every gradation in the matter of distance from one another, and I have described an instance above in which a gap was greatly widened by the complete destruction of a forest-patch. The evidence generally is suggestive of former continuity in the section I am particularly concerned with, and of the view that the patches actually represent our most primitive type of forest.

Should we accept this much it is hard not to extend our conclusions. The actual distribution of a number of plants and animals, and the facts touched on in the last paragraph of Section 2, suggest strongly that the idea of a great East African forest that once connected Knysna with Elgon and beyond is not far-fetched. Our Gazaland dense forests are the meeting-place of Nyasan and Southern species, *Podocarpus milanjiana* carries us on beyond to the German and British East African mountains, and cases like *Khaya nyasica* (not much more than a sub-species of *K. senegalensis*) take us round with a swing, *via* Nyasaland, into the forests of the west. Finally, *Pseudocalyx*, *Pœcilostachys*, and other apparent relics of the connection with Madagascar, enable us to picture the forest as existing already in the earlier Tertiaries, when, as the great nummulitic deposits between Chirinda and the sea alone suffice to show, the country's configuration must have been very different, and land must have been under water that to-day carries isolated forest and was once perhaps clothed with it.

5. Factors in Forest-distribution.

(*a*) High Primitive Forest.—I have already incidentally indicated the view (1) that the general area in which Chirinda-like forest can occur is strictly limited by conditions of *rainfall;* and (2) that *one* important factor which has brought about its present scattered distribution is *the annual grass-fires*. It has been suggested to me that the rainfall generally is gradually diminishing, and that this may be the factor that is causing the forests "to die out."

Directly, no—or so one would say: for the surviving forests are, for the most part, in far too flourishing a condition to allow one to suppose that any such detrimental influence is at work within them. At the same time, a realization of the exact conditions under which some of them grow suggests that the possibility should not be lightly dismissed. Thus Neave (*Geographical Journal*, February, 1910) writes of the "mitu," or

dense forest-patches, of the high plateau country, the backbone of which forms the water-shed between the basins of the Congo and Zambezi rivers, that "they are commonly on the source or banks of a stream." Many of our kloofs—with streams or probable underground moisture—carry dense bush that is practically a sub-community of our high forest formation, and often contains a considerable sprinkling of true forest forms, as *Khaya*, *Piptadenia*, the shrub *Tricalysia*, and others I might name. The forest-patches on dolerite, as I have said, often occupy the hill tops, but the red loam in any case probably conserves moisture better than the sandstone. Of the little patches on the latter formation that I have referred to more particularly earlier, it is interesting to note that the elongated one, nearest Chirinda, now no longer carrying forest, follows roughly a shallow kloof, in which a spring has sometimes appeared after great downpours in our older, heavier, rainy seasons, while those nearest Chipete were connected this last season, after a 31.4-inch rain in four days, by quite a stream—on a convex surface with no trace of a previous surface-flow excepting from the lowest of the patches. The survival of one or two other very small patches has obviously been aided by the presence of low, wide-spread ant-heaps of *Termes bellicosus*, full, of course, of collected humus. So that, on the drier soils, it is in the damper places or above probable subterranean waters that forest most tends to survive. Again, it is the rule—which has its notable exceptions—that the forests have eastern and south-eastern aspects.

Actually, all this is explicable also in relation to fire, and against the other interpretation we must place the present non-afforestation of the vast bulk of the doleritic area with the aspect described, and the ease and success with which forest-trees can be re-established on the drier soils, continuing to take care of themselves if looked after for the first season or two, and then merely protected from fire. Also the fact that considerable pieces of Chirinda are on the sandy soil, yet carry flourishing forest—lower and slightly less dense, it is true, on one of them, yet apparently thoroughly healthy. Chipete, it is true, has latterly rather the appearance of decay, but it is on the dolerite, and I will show below that this appearance is probably due to another reason than drying up. It must be remembered, for the piece of country with which I am specially dealing, that the rainfall is even now heavy right from the coast to the mountains, excepting within particular circumscribed areas. If the inner plateau lands of lighter rainfall, which line the great curve of dotted forest and comprise much of South Africa and most of Rhodesia, ever boasted high forest, and this were destroyed before the advent of fire-using man, one might be disposed to attribute it to a general decay accompanying a falling rainfall. I doubt whether our coast rainfall has yet fallen so low as to act thus as a directly destructive factor, and it is interesting that seeds of forest-trees, sent by myself many years ago to the

lower-rainfall plateau area (at Salisbury) have produced flourishing trees. At the same time, I abundantly realize that my personal observations have been carried out from a centre that is not only blessed with good summer rains, but is exceptionally favoured through the relative cool that accompanies a considerable elevation, and through the usual possession of light winter rains in addition. So I will not generalize.

On the other hand, a reduced rainfall—and even a relatively slightly reduced rainfall—might well have produced a powerful indirect effect. After a good rainy season the heavy green fringe of *Hypoestes* and other tall herbs and shrubs that surrounds our dense forests lets little fire in, and it cannot travel if it gets in. In a very dry year the opposite tends to happen, and there can be little doubt that dry cycles must see a vastly greater destruction of forest than wet ones. Since grass-veld became its neighbour and grass-fires became the order of the year, the Chirinda type of plant formation has depended for its continued existence on the adequate co-operation of herb and shrub and tree. The herbs that belong to it cannot flourish and keep back fire without the coolth and relative moisture that is retained, *when the rainfall gives it,* by the canopy of the trees and shrubs and lianas, and if the trees are deprived of luscious greenness in their herb-fringe and carpet, they are also deprived of their protection against fire. It is even possible that the trees of the formation might inhabit a far wider *general* area than they now do were it not for this indirect result of a smaller rainfall, and the fact, already referred to, that at least one of them flourishes under the latter condition in the Gardens at Salisbury (I do not know, however, what the cultivation has been) may support this hypothesis.

I have already suggested that this indirect factor will be specially powerful where the soil is relatively poor or sandy, and that this may be one reason why forest tends to disappear from soil of this kind first. It may just be worth suggesting further that another indirect factor working in the same direction—a less important one—*may* have been—elephants. At any rate, my recollection of their work in the Sitatonga forest, in which they were somewhat plentiful at the time of my visit, leads me to suspect that the rather poor forest that tends to occur on the poorer sandy soil in Chirinda would be more liable to such damage by elephants as might tend to let fire in. Whether, when they were here in the great numbers described by old natives, their destruction of the "green fringe" actually did more than counterbalance the lessened ferocity of the fires that might have resulted from the general trampling (yet greater drying) of the grass-veld round the forests, can best be settled by observation of forests in which they are still abundant, but I am inclined to think that they may have acted as a slightly accelerating factor in the destruction of forest by fire. A more important accelerating factor will have been the late fires that were in vogue during the native *régime*. According to all

accounts, most of the burning was annually postponed till September and October, when the grass is very dry, and when the forest fringe and carpet is also at its driest, owing both to the hot sun and to the strong, dry winds that are blowing continually from August onwards. These late fires are often exceptionally fierce and destructive. It is also possible that throughout the hot, low veld the rate of destruction may have been comparatively high.

A *retarding* factor may well have been the grass-eaters of our once great ungulate population, and the known facts in this connection even constitute a strong argument against the view that fire has been an important factor at all. We know from old hunters that formerly in the Free State and elsewhere these grass-eaters used to eat the veld bare, and it is the fact, apparently, that in British East Africa to-day, and at any rate in considerable portions of German East Africa, they eat the grass so close that fires do not take place. Our own older natives state that this has happened over particular areas even in the section with which I am more particularly dealing, but that it has not been a general phenomenon, annual fires having taken place through the rest of the country throughout their life-times.

This shows that even with only a native population in the land it has been possible to have periods of grass-fires. I have already referred to a considerable *destruction* of forest that took place through fire 30 years or more before the white man came. Selous records the grass-fires as occurring annually in his hunting days in the Transvaal, Bechuanaland, Matabeleland, and Mashonaland; they have been, apparently, as regular a phenomenon in Northern Rhodesia with buck still plentiful. I do not know, however, whether this applies back to the time at which the whites entered that country. I well remember references to the severity of the annual fires in Nyasaland in early numbers of the *B.C.A. Times*; and I will shortly quote a passage from an account of Alexander Whyte's botanical exploration of Mount Milanji 26 years ago (*Trans. Linn. Soc.*, 1894, vol. iv, Pt. 1, p. 3), that shows them to have been occurring annually before that time with "deplorable" and "devastating" effects on the forest. All this suggests strongly that such a superabundance of antelopes, etc., as will completely stop grass-fires, has been a local and temporary phenomenon, alternating with periods of fire; and, of course, so long as fires take place at all, they will, in dry seasons, destroy forest.

But the three strongest arguments in favour of fire as a factor are indirect. The first is, the result of protecting forest from fire. I will describe this in Section 6. The second is this: The grasses which covered this country when the treks came in still cover it wherever fires have continued annually, and grazing has not been excessive. Where, on the other hand, grazing has been very close and burning has for long stopped, new grasses are replacing the old ones. The third is the strongest argument of all. It is afforded by the existence to-day, over all this vast

area, of *pyrophytic* trees and shrubs. Such perfect adaptation to a condition of annual fires as we see in these and the differentiation into numerous daughter species, which probable pyrophytes have already undergone, will hardly have come about in less than very many thousands of years. The fact may have an interesting bearing on the antiquity of man in this part of the world, for, now at any rate, no regular fires take place excepting through his agency. In the days when our igneous rocks were forced to the surface things may have been different, and the pyrophytes might have made some beginning. The analogy of the vegetation in areas still actively volcanic should be useful here.* Of course, if such a plant community exists in any place which can be stated confidently never to have undergone a fire-period, the argument goes. Meantime, I am inclined to regard it as conclusive.

It must be remembered, I think, that differences in the numbers and hunting proclivities of the natives and the number of the lions do not exhaust the possible factors that may have produced fluctuation in the ungulate population. The rinderpest, which so reduced the numbers of some of our larger buck, is unlikely to have been the first epidemic that has swept through them. The process of immunization to the effects of *trypanosomiasis* must alone have taken long, and led to great reductions in their numbers, though it may, of course, have been completed before fires began. The immunity, if any, of the older African races of man should have a bearing here.

The actual process of forest destruction is well described in the account of Whyte's exploration of Milanji in 1891, already mentioned: "It is deplorable to witness the devastating effects of the annual bush-fires, from which even this lofty and all but inaccessible retreat is not exempt. During the dry months of August and September these fires, originating from the villages on the lower slopes of the mountain, gradually creep up the precipitous cliffs from tuft to tuft of grass until at last they reach the grassy plateau. Once there the work of destruction is rapid. The fire rages along the table-land and eats its way along the edges of the remaining belts of forest, annually scorching, if not burning, the bark and timber of the outside trees, and killing outright the young seedlings. In exceptionally dry seasons it appears that these fires have even penetrated some of the damp forests, and hundreds of giant cypresses lay prostrate . . generally burnt right through at the base of the tree."

These are the two stages—first scorched, later burnt into or through. The process of destruction in ordinary years is

* Of the plates illustrating Dr. Tempest Anderson's account of the volcanoes of Guatemala (*Geog. Jnl.*, May, 1908), one (Pl. II, "Santa Maria, from the slopes of Cervo Quemado") might represent a scene in the poorer pyrophytic wooding between Melsetter and Umtali. Another (Pl. VII, "Tropical forest on the slopes of Attilan") is exactly Chirinda, without the big trees.

slower than one would perhaps gather from the above account, and the forest may even hold its own completely along considerable fronts for very many years, explaining the fact that in some places the "Sand-apple line" even now nearly touches Chirinda, and conveying sometimes, to the mere traveller or short-term resident, the impression that "the patches of dense-crowded forest trees . . . are seldom or never affected by the annual bush-fires" (S. A. Neave, "Zoological Collections from Northern Rhodesia," P.Z.S., June, 1910). But in a dry year the fire runs in further, and a succession of two or three dry years tends to produce the result described by Whyte. It is quite interesting that the destruction of portions of the Chipete and Chipungambira forests already referred to should, according to my informant, have coincided with "the last great famine"—in, I should judge from my estimate of his age, about 1860.

Other factors: Cultivation.—I have laid stress on fire because there is very clear evidence of its destructiveness in the recent past, and because it is the only important factor that can be seen at work here to-day. But another factor of possibly high importance must by no means be lost sight of. I have suggested (*Journ. Linn. Soc. Bot.* xl.) that the grass-fires "obtained their original hold on the forest-lands during some period of dense native population." With a better realization of the time required, I would no longer say "original"; but clearing for cultivation, which was in my mind as affording starting-points for fire, may itself have contributed to the destruction. It is very interesting to read Thomas Belt's account of the way in which the whole Pacific slope of Nicaragua has been, apparently, cleared thus by the Indians *without* the aid of fire* in the course (he believes) of thousands of years, the trouble of weeding the grass that soon comes in being in this case the incentive for the continued use of the forests to the neglect of the still fertile savannahs; and Roosevelt records the destruction of much dense forest in East Africa between the Aberdare Range and Mount Kenia" by the Kikuyu tribe in order to give them new soil for cultivation," while "similarly destructive agricultural methods have separated portions of the Elgon and Nandi forests, which were formerly continuous." Miss Lilian Gibbs, in a most interesting paper describing the last of her adventurous explorations (*Jour. Linn. Soc.*, 1914, xlii., no. 285), shows us a relatively early stage; for she describes how the primary forest of Borneo still covers the lowlands north of Kinabalu, where there are no natives, but has elsewhere been destroyed by them for cultivation up to an altitude of 3,500-6,000 feet, and, in the valleys, considerably higher (p. 11).

The clearing of this type of forest is not the rule amongst our natives to-day—I have seen only one small instance of it, in Portuguese territory—but when Chirinda-like forest covered a large proportion of the country, there was more temptation

* Belt does not mention fire.

and (if the population were large) less choice, and this mode of cultivation may have been as much the fashion here as it was in Belt's day in Nicaragua. A recent period of this kind might explain, far better than fire alone, the clearing of certain rich trap-areas, like large parts of the Jihu, since the sand-apple line was fixed—subsequently, that is, to another kind of period during which the disappearance of forest from the poorer or drier soils first was the rule. Not so recent as to have left memories or traditions—for of these I find no trace: and not concluded by the Zulu incursion—for this, an incorporation on this side of the Sabi rather than a conquest, appears to have interfered so little with the life of the people as to have been unlikely to have caused the cessation of such a custom. Yet it might have been coincident with the Arab trade and the better days of the Varozwi.

A fact that perhaps may tell against the importance of the above factor is that some of the most important forests in Africa outside of the solid area occur far up on the route of the southward migration of the races, and where blocking and crowded populations would appear to have occurred in the process.

An instance of the effect of the constant *cutting of saplings* by natives will be given below. Continued long enough by sufficient natives, it would certainly end in the destruction of the portion of forest affected.

Shade.—Roosevelt and Heller (*African Game Animals*) suggest as the *raison d'être* for this "massed" type of forest and its sharp demarcation from the surrounding grass-veld that the trees composing it seem capable of growing only "where they are protected from the maximum quantity of sunlight." The need is doubtless felt by certain species—as it is, I believe, by the Cape Stinkwood—and the shrubs and herbs are also, doubtless, largely dependent on shade. *Coffea ligustroides*, planted by me without shade, failed, and shrubs of *Conopharyngia usambarensis*, though they have grown vigorously, show some leaf-crumpling and a flecking with yellow that indicates some chlorophyll-destruction. Seedlings, again, in their first dry season, have certain small requirements, which may be better referred to below. Beyond this, the view does not seem to apply to our big forest trees. Many years ago, in experimenting in shade-trees for coffee and standards for *Landolphia rubber*, I planted forest-trees in the open sunlight, did not irrigate, and, except at first, gave no cultivation. Each is now growing in isolation, surrounded by grass but protected from fire,, and the latter seems to be, at this stage, its sole demand. The failure of one individual (*Chrysophyllum* sp.) has been counterbalanced by the success of another that has come up naturally, in broad sunlight, outside the forest, and *Khaya nyasica*, *Lovoa Swynnertonii*, and *Ekebergia Meyeri* (Meliaceæ), *Teclea Swynnertonii* (Rutaceæ), *Schefflerodendron gazense* (Leguminosæ), *Pygeum africanum* (Rosaceæ), *Chrysophyllum fulvum* (Sapotaceæ), *Strychnos mitis* (Loganiaceæ), *Maba mualala* (Ebenaceæ), *Croton*

Sylvaticum (Euphorbiaceæ), and *Celtis dioica* (Urticaceæ), all big trees of Chirinda, are flourishing under the unwonted conditions in spite of a somewhat dry series of years. The same may be said of *Widdringtonia Whytei* of the mountain forests, and I have been told that this tree, amongst others, comes up, and grows up, outside the forests in unburnt portions of German East Africa. My trees named above, like those of the European forests, show clearly their independence of the massed condition for such protection as they may need from excessive sun—and wind—by readily protecting themselves when necessary through lower branching, a stockier growth, and, in one or two cases, denser foliage. The firmer, smaller "sunlight" leaves were naturally assumed early, in ready adaptation to the early need for reducing transpiration.

The moisture that canopy—and especially, as in Chirinda, layers of canopy—directly and indirectly conserves is the real essential: not to the big trees, once started, for they are shade endurers and shade makers rather than shade lovers and sunlight fearers: but to the formation as a whole, in keeping green its defence against fires. Yet neither the advantage in relation to fire, nor defence against drought, can be regarded, I think, as the forest's *raison d'être*, though they may explain its long survival here as against possibly less efficient sub-types of the same formation that may have gone first in the drier areas; for what is essentially the same general type is found elsewhere in the world with fires absent and a rainfall approaching 200 inches. The fact is that, with vegetable reproduction what it is, it is not crowding, but the converse that most needs accounting for, and the latter is probably in most cases due to thinning agencies or conditions of hardship. The sharp demarcation between veld and forest—the "solid wall" of Roosevelt and Heller, "definite line" of Belt, and "abrupt cliff" of my own description (*Jour. Linn. Soc., Bot.* xl.)—is, in the places in which we see it to-day, man's handiwork, direct or indirect; but the difference is in any case between two plant societies, each of which normally supplies conditions that are intolerable to the other, and make invasion and commingling impossible except with outside assistance.

Duration.—The various complicating factors I have referred to earlier make it futile to try to estimate the probable duration of the period of destruction. A very crude estimate, based on fire alone and on a higher average rate of destruction than is observable here to-day in the case of unprotected forest-patches, gave the figure of 105,000 years. Even if we should admit the systematic destruction of forest for cultivation during many centuries, the figure would still have to be great. Yet man's association with extinct animals at Broken Hill suggests that this need not, in itself, be a formidable objection to the view that primary forest of the Chirinda type once covered the strip from the mountains to the sea, and was removed chiefly by the two agencies I have suggested—especially by, and for

long only by fire. Such a tradition as that mentioned, I believe, by Theal, to the effect that the Kaffirs on reaching the Limpopo found savages there who, at that late date, had no knowledge of fire, might tell against it. But even if the tradition be well-founded, it does not seem quite impossible that a type as low as are the present Vaalpens of that valley might have remained without fire for an immense time even with fire-using Bushmen and Hottentots in the country.

It seems impossible to say whether the retarding factors I have referred to earlier will have been more than counterbalanced by accelerating factors. A single, really prolonged period of drought might have seen *immense* forest-obstruction. Again, a slow and gradual start from a few small centres is possible, or, on the other hand, the fires may have come in along the whole dry western front, the forests of the inland plateau country, if they existed so late, having been burned off first. It might also be argued that the dense forests are mainly a mountain phenomenon, and that it is unnecessary to assume that, at this latitude, they may have extended to the coast. A once more or less continuous strip of forest on the mountains and eastern foot-hills would explain distribution, and have needed less time for its destruction. Against this we must put the fact that the South Melsetter and Mossurise forest-patches, though occurring at from 3,000 to 4,000 feet, are essentially of a lowland type, that such patches occur also in the lowlands and not far from the sea, and that dense, high forest is similarly found in the lowlands in British East Africa.

(*b*) Pyrophytic Forest.—The trees that are associated with the annually-burning grass-veld are fully as intolerant of dense-forest conditions as are the grasses themselves. Adaptations of the bark enable them (once well established) to meet the fires with nothing worse than a loss of leaves and their seedlings survive both fires and winter drought in a marvellous way; but the latter, in contrast to the true forest seedlings which will keep alive for years in the undergrowth awaiting light in order to grow up, cannot long survive damp and shade. I have numbers of times seen masses of *Uapaca* seedlings in particular, dropped in the forest by Kafirs or baboons, germinate, yet fail every time to persist. It is correct, therefore, to say that the factors that have reduced the dense forest areas have also brought about the present wide distribution of the trees of the pasture-lands.

Derivation.—Dr. W. L. Thompson has said to me that he has been much impressed with the probability that the one type has arisen from the other by the fact that the same genus so often possesses representatives both in the forest and in the pasture *Ochna, Eckebergia, Rhoicissus, Parinarium, Eugenia, Vangueria, Strychnos, Vitex, Bridelia, Ficus,* are amongst the instances of this quite striking fact. If (as I think we must) we regard regular fires as a relatively recent phenomenon and the present "wooded-pasture" trees as belonging to a later, specialized, definitely pyrophytic type, it certainly seems not entirely unlikely that if we could go back far enough we should find that they are, each

one, eventually thus derived from a forest-inhabiting ancestor. But the present wide distribution in Africa of many of them suggests that for these we should need to go back very far indeed, and that the replacement of any particular great piece of forest has probably proceeded (as it does under our eyes to-day) far more by immigration and spread of already-specialized forms than by the transformation of its own trees. It is likely enough also that some of the forms came in, already ombrophobous, from an equivalent to our present grass-veld that may already have existed in drier areas long before fire, in the hands of man, became an important factor. This would entail a less violent re-adaptation than is presupposed in the transformation of a forest-tree into a pyrophyte and, especially, of its seedling into a seasonal xerophyte, and the indirect palæontological evidence, such as there is of it, seems to point to the existence of open country in early Tertiary times. Against the view that such country may have existed *in potential forest areas* before man and his fires commenced to destroy, may be placed an argument which anyone who has lived long in this country—in this part of it at any rate—will have seen growing up under his eyes. The fact is that land from which fire is excluded tends to go back to dense bush. Even the more open grass-veld here is full of stumps that seldom get further than a one season's shoot.* The very fires that have rendered their existence on that ground possible, by driving the forest off it, keep them from growing up until, some year, a poor burn, it may be, or no burn, allows of a second season's growth being superadded to the first and gives a more fire-resisting bark to the latter—just as the shade that secures the survival of the forest seedlings may also keep *them* back till the sun, some year, gets in. Keep the fire from such a piece of ground—or burn too soon—for several years, and these shoots grow up and eventually in places become so dense as to reduce the grass and the severity of the fires and to allow semi-forest types as *Markhamia lanata* and *Albizzia chirindensis* to spring up amongst them as I shall describe below, and eventually to replace them. The result, when this occurs so far from high forest as not to obtain seeds from it, is a form of dense thicket, that is not uncommon in this section. I am not at all sure that very large parts, at any rate, of the great rubber-forests of the Portuguese lowlands may not be of this type. I was much struck, when there, by the frequent intermingling seen of the trees usually found in pasture with the shrubs and climbers of the denser growth and the smothering by these that was actually in progress.

The semi-forest types referred to just now, and especially such a one as *Rauwolfia inebrians*, at home even in Chirinda yet capable of holding its own outside with only a little protection from fire, may represent the sort of form through which our

* *Cf.*, also, Neave ("A Naturalist's Travels on the Congo-Zambezi Watershed," *Geog. Jnl.*, Feb. 1910, p. 138"): "The tree-stumps . . . have to undergo a very keen struggle to survive the annual bush fires."

more specialized modern pyrophytes have descended. The *Rauwolfia* appears to owe its dispersal mainly to birds, and it seems to me highly significant—but I do not know whether an examination of other African forest areas would give a corresponding result—that those forest-trees which possess congeners in the fire-swept pastures are, for the most part, the ones which produce edible fruits: all but one in the list above are of this category. The seeds of these, dropped into every conceivable sort of station outside, would occasionally hit off conditions which would be, in varying degree, supportable, and the transformation might thus come about by easier stages than seeds dropped on the outskirts of a disappearing forest, and bound in a year or two to face the full severity of the fires, could hope for. That the migration has not been from the veld to the forest seems rather to be suggested by the present uniformly inhospitable conditions in such forests as Chirinda, though with elephants still abundant in them, or natives making clearings, this may not have been the case to the same extent in the past.

The Influence of Man and other Animals on this Type of Wooding.—I have referred to fire as a factor that may repress, temporarily, the growth even of pyrophytic trees. It has not, in the past, been the only repressive factor. It is a matter of comment amongst our Kafirs generally, and also amongst white residents, that the country north and west of Chirinda has been becoming wooded with pyrophytes at a great rate in recent years, and *Parinarium curatellæfolium* has been making great strides in the district generally. I consulted, independently, two aged natives. Each said that in his youth the country in question was as bare as the strip to its north still is, or barer. Asked to account for the change, one said that even *Uapaca Kirkiana* (now the dominant tree and a help in famine) was then too scarce to supply the local population, and that parties of natives used to go regularly a dozen miles, to the Buzi, to collect the fruits. He presumed that the seeds thus carried must have resulted in some of the present groves. This explanation is by no means capable of accounting for all the facts even in relation to this one species, and the old man was puzzled to explain the similar increase on the part of *Brachystegia*, the fruits of which genus have no such interest for the natives; but I mention his statement because it suggests how great a factor for rapid dispersal the natives may in some cases be.

My other informant—an old doctor—from whom I had long previously obtained much of the information with regard to the medicinal uses of plants that I included in my paper on the trees and shrubs, stated that, for the most part, neither the *Parinarium* scrub nor the present groves of other species were new. He had seen them as a child, *but*—the plants that have now made trees were then regularly browsed back to the ground by the great herds of buck that grazed our veld before the white man came.

As a partial explanation this seems to me good, and others have confirmed it. It does not account for everything, for, if

some of the now older groves were actually as small in the old men's youth as they stated, then they had already, as a fact, increased somewht *before* the white man came. It is probable that the increase in the numbers and virility of the local native population which will have accompanied the settling beside Mount Chirinda of the great invading Chief Umzila with his warlike Zulu following will itself have started the process of preservation from the buck—at any rate in the immediate neighbourhood of the main kraal, and some details I have gleaned from old men, but have not space to discuss here, support this view. But the wooding has undoubtedly made its *great*, and general, spurt since the white man's arrival, and this may have been due to the factor suggested as well as to the tamer fires that result from the white man's earlier burning. It is not necessary for most of the species to suppose that the present trees are entirely, or even mainly, old stumps grown up, for the main groves are admitted to have been represented by clumps even in the old men's youth (Umzila placed his first kraal beside such a clump; it now covers a hundred acres), and, the natural reproduction being good, it has merely required the removal of the antelopes to allow it to become effective—the fires permitting. But, for *Parinarium*, as I have shown in my "Melsetter" paper, natural reproduction offers no adequate explanation and old Mi'a'owe's explanation, added to that connected with fire, holds good in its entirety.

Man's influence on the vegetation is a difficult, if interesting, thing to assess with any exactitude. In this locality the black man troubles the large trees of the forest but little—unless one happens to contain a bees' nest, in which case its felling merely anticipates its death from the decay already begun; but when present in great numbers or where the forests are very small, he seriously hinders reproduction by destroying the younger growth. I have been told that Umzila's people, arriving in an otherwise nearly woodless land and commencing building operations, felled an immense amount of small forest growth and destroyed some small patches, not containing many large trees, in a single day. The mere trapping of bluebucks, against which animals Gungunyana (Umzila's successor) is said to have at one time instituted quite a campaign, must have entailed a continuous destruction of saplings for the trap fences. The process was apparently insufficiently severe, or (better) insufficiently prolonged, to cause the decay and disappearance of any portion of Chirinda, but I am inclined to attribute the present rather decayed appearance of the older portions of Chipete to the fact that several kraals, including the Chief Mapungwana's, have always been located just to its east, and that all the young growth was regularly cut down until I commenced to protect it. There is consequently a gap of very many years between the older trees and the next oldest growth and this gap shows up when the former pass maturity.

The natives' influence on the more open wooding would seem

to be, on the whole, repressive. He shifts his gardens every few years, and wherever he makes a new one he first lops off the branches, piles them round the base of the trunks, and, firing them, destroys a patch of bush. Some of the trees of the wooded pastures bear favourite fruits, or support edible caterpillars. Improvident of the goose that lays his golden eggs, he frequently chops these down to collect the "eggs" more easily. He is a far more efficient disperser of the seeds of edible fruits than is the white man, but he fails to keep down the buck that eat down the seedlings. He even reinforces them—with goats.

The white man, on the other hand, chops down some of the mature forest-trees but prohibits the cutting of younger growth. He protects the forest from the annual fires, and tries, if anything, to extend it.* But he also conserves the relatively useless pasture-trees that are making his agriculture expensive and will gradually reduce his grazing. Jealous of his proprietary rights he forbids the native to cut them; an effective and blood-thirsty hunter, he destroys the buck that kept them down; his earlier fires let them make a start, and his sheep and cattle (more frequently kept than goats) definitely encourage them by replacing only the grazing antelopes and keeping down chiefly the trees' competitor and fire-bringer, the grass. And so, if he is not so near a town or mine as to be able to chop all down and sell it, his land reverts to wooding—of a very poor kind, whether you look at it from the point of view of direct utility (as compared with what can be obtained from a quite small plantation of better-class timber), or from that of its influence on soil conservation and the springs. The latter is probably *nil*, or worse.

6. Reconquest by Forest.

I am nowadays commencing to see a definite, if incipient, advance on the part of a considerable line of forest as the result of having protected Chipete and my section of Chirinda from the fires for fifteen years past, and the process is worth describing.

The sub-community represented by the *outskirts* plants has made the first and *great* advance. The green fringe of *Hypoestes aristata* has pushed in places as much as 40 or 50 yards into the grass and is supplanting it, the luxuriant climbers *Dioscorea Schimperiana* and *Helinus mystacinus* are in places wandering out and smothering it, and the large shrubs *Vernonia podocoma* and *Vangueria apiculata* and small, laburnum-like *Calpurnia lasiogyne* are following up this advance and making a thicket. Most prominent of all, however, is the semi-tolerant species *Albizzia fastigiata chirindensis*. While the fires lasted, this tree hugged the forest, but now it is thrusting out boldly into the grass-veld—individually up to eighty and a hundred yards, and closer growth, already forming clumps and little woods, up to thirty and forty

* At Chirinda I think we recognise our obligations towards the forest. But it must be admitted that the above has not been the attitude of the white man in all countries.

yards. The forest proper is slowly bringing up the rear, as the shade advances, with a small but quite definite advance of from three to five yards, the out-leaning trunks of *Calpurnia* and other outskirts species that used to be on its outside being now that distance inside it, and in a more or less decaying condition. Only in one place, a broad indentation of Chipete, has the forest advanced as yet in a really sensational manner—90 yards at the deepest spot. It has been enabled to do this under cover of the shade of thorn-trees—also *Bridelia, Catha* and *Erythrina*—that had come in with the invading grass-veld and grown up, and with the liana *Toddalia acuminata* as its advance guard and shade-connecter. It is curious to see the above trees—old trees, and, some of them, as the Bridelias and *Erythrina humeana,* marking former limits during the process of forest-destruction—standing far inside the forest, the thorn trees mostly already dead. But an occasional forest seedling is to be seen beyond even the general slower advance of Chirinda, pushing up amongst the outskirts plants; and *Teclea* in special numbers, but a few other species too, are coming up under the shade of the *Albizzia* clumps and even—aided, doubtless, by the layer of humus that has already formed in such positions—that of isolated thorn-trees growing in the unburnt grass-veld. This suggests that far greater progress on the part of the forest itself will be visible at the end of a second fifteen years than is to be seen now, and it seems likely that a final cessation of grass-fires would, other things remaining as favourable as at present, result in the course of ages in the retaking by the forest of its lost ground, just as Belt claimed would happen in Nicaragua were the felling there for cultivation to be abandoned. The process would be slow, but less slow, I believe, than the destruction has been, for *Hypoestes* and *Albizzia* are energetic and far-pushing pioneers. Also the shade and humus of the forest's rivals, the trees of the veld, would be freely used by it for their supplanting.

Not merely along the general advance, either; for new forest centres would be created under them by fruit-eating birds and would accelerate the closing-up process as they came into bearing. This has begun to happen already, for *Haronga madagascariensis,* a tree of the dense-wooded kloofs, is, over a certain area of ground near Chirinda, coming up thickly under *Eugenia latifolia* and small *Parinariums* in the unburnt grass-veld, and, growing rapidly and overtopping them, is killing its nurse-trees and itself coming into bearing and being visited by numbers of bulbuls. The kloofs generally would help greatly in the re-afforesting of the mountains. Those of a portion of the northern slope of Chirinda that is covered with *Uapaca* and *Brachystegia* wooding, but has been little burnt of late had previously had their pyrophobe trees reduced by the fires to a mere thin line along their bottoms. Yet now they are climbing out again, and—*Eckebergia Meyeri, Pygeum africanum, Teclea Swynnertonii, Sapium Mannianum* and *Eugenia ovariensis,* but especially, and in numbers, the pioneers *Haronga, Albizzia,* and, to a less extent,

Bersama—they are entering into successful warfare with the pyrophytes of the lower slopes, while the big climbers *Landolphia, Choristylis, Canthium, Rhoicissus, Uvaria, Secamone,* and *Lygodium subalatum* are flinging themselves out over *Brachystegias* and *Uapacas,* and already smothering some of them. That the pyrophobes should be capable of growing up under trees so exclusive and hard on the ground as the last two *genera* has interested me immensely, and prompted the suggestion I shall state below; but our forest-trees are obviously good fighters. It is possible that few trees have so drying an effect on the ground as Eucalypts—they have quite dried out a small swamp that used to provide me with *Anopheles.* Yet, in my close-planted gum shelter-belts, forest trees and shrubs, as well as several importations, have come up everywhere and grown freely. They include the fine trees *Trichilia chirindensis, Eckebergia Meyeri, Pygeum africanum, Maba mualala, Croton sylvaticum, Sapium Mannianum,* and *Celtis dioica.*

The prompt advance of forest that follows the cessation of fires is an argument in favour of the latter as the agent of its destruction. The circumstances under which the seeds of forest-trees germinate and succeed outside the forest enable one to gauge their actual needs. I have seen seedlings that have sprung up in numbers on the outskirts and flourished in broad sunshine, while the rain lasted, dry up and disappear as the dry season progressed. Here the ground was bare of fallen leaves, or practically so, and baked dry. On the other hand *Khaya, Trichilia, Pygeum, Rauwolfia, Teclea, Croton, Ehretia, Schefflerodendron,* and *Landolphia* sown in ploughed ground survived their first dry season well without shade, the fact that they were covered up, together with the moisture retained by the ploughed ground, and its penetrability, evidently fulfilling all needs. To-day they form a well-grown grove. *Albizzia chirindensis,* again, gives very little shade when one would expect it to be much wanted, for it drops its leaves in June and early July. Yet it seems a successful nurse tree. There is always a fair amount of good humus layer under it, and this, apparently, is able alone to carry a fair proportion of the seedlings it shelters through their first dry season. In general, I should say that one never finds a forest-seedling surviving the latter when some slight layer is not present, unless it finds tilled ground. The seeds slip or are washed down between the undecomposed leaves, and are sheltered by these; and the layer generally, helped by shade when present, tends to retain much moisture between the falls of rain, and also provides a penetrable bed for the seedling's roots, with the result that it has begun to be established by the time the dry season comes. If, now, the humus is such as to ensure the continuance of a sufficient moisture supply, the plant does not fear sunlight. If not, it burns unless shaded. Thus moisture, rather than shade, is the real necessity in their first season, for, at any rate, a great many of the finer and commoner trees of this type of forest, though it is seldom that the

former is sufficient, outside the forest, to enable them to dispense with the latter. *Inside* the forest the tendency of shade is to keep them back, and of sunlight to bring them on. In cultivation, they would probably nearly always need either initial shade or tilth—or water.

The effect of a large antelope population on advancing forest can best be noted where the former still exists. Buck mostly avoid forest. The little "blue-buck" (*C. monticola* inhabits it, and bushbuck lie up in it, but feed outside. The stomach, examined by myself, of an individual that thus haunted the forest, contained recognisable remains only of plants of the grass-veld outside.

A Suggestion.—May it not prove possible, for certain purposes, to utilize our already-established pasture-trees as nurse trees in artificial afforestation, at any rate under favourable conditions of rainfall, situation, etc.? I do not know whether it has been attempted. I have myself, as a very small experiment, planted gums (*G. botryoides*) in a *Uapaca* grove under conditions apparently unfavourable to them—a high and dry spur, with mixed shale and sandstone right on the surface and no preparation beyond holes that would just take the roots—and they have over-topped and are killing the *Uapacas;* but gums, not needing shade, and being worse than useless for the purpose that this sort of planting might be particularly used for, are not so much to the point as the other observations I have described.

The pasture-trees make good shelter for stock, and contain a few really useful species, and one would be sorry to sacrifice the gorgeous spring tints of the *Brachystegias*—a landmark in the year; but the type of forest is, all the same, a relatively useless one, and, where not near mines and towns, is tending to swamp the pasture. I have referred to its probable inefficiency in the matter of water-conservation. The humus is more or less burnt off annually, the canopy is commonly so thin and broken that it fails adequately to protect the ground from the sun and check evaporation, or greatly to lower the temperature, and the wooding is so open below and around that the drying winds blow through unchecked. Mr. Hutchins, if I remember rightly, suggested many years ago that the moisture exhaled from the leaves probably greatly exceeded that retained by the shading, and this, for most of the species, seems likely enough. It is doubtful, again, whether, on a steep slope, the thinning of the grass that takes place under a close grove does not lead to greater waste than is prevented by the roots of the trees—at any rate where the fallen leaves are burnt. Finally the drying-up of the springs of a slope in which I am interested has gone on coincidentally with its becoming more and more completely clothed with this type of wooding. I do not connect the two phenomena necessarily, but I doubt whether it would have happened to at all the same extent under pine or Chirinda-like forest. I have several times heard the cutting of this open wooding denounced as likely to "dry up the springs" or "diminish the rainfall,"

but in view of all I have just said, I do not feel that it need be regretted if it should be possible to convert an occasional hill-side of it into useful forest.

The value, as nurse-trees, of a drying type of wooding may well be questioned. Yet the observations I have given suggest that it may serve, and the impression left with the observer is that it only requires the continued exclusion of fires and an abundant seed-sowing to extend over the whole slope I have mentioned the operation that is already taking place in the kloofs, and on part of the hilltop. Obviously the growth obtained from such planting could not be expected to be so even or the returns at all so early as from ploughed ground, and it would be worth attempting only in a case like the above, in which not early returns, but the rescue of springs at as cheap a cost as possible was the primary consideration.

Albizzia or *Erythrina* or some other useful tree might be used as a shade connecter and wherever natural wooding was absent, being either sown at stake or put in as live posts; and a later sowing made at stake, at stations roughly hoed in the grass, with the better native forest trees as (in these parts) *Khaya and Pygeum.* To get its full moisture-conserving effect from this type of forest, and to guard it against fire, one would doubtless have to follow nature and include some of the shrubs, if not of the lower-canopy trees, in one's sowing, and later, in order to bind the humus on the steeper slopes and add a shade-layer, to introduce forest-grasses at intervals. They would soon spread and meet. Actually, this forest never makes *much* humus, though masses of leaves fall, and there being no white ants and no fire to destroy it, one expects to see accumulation in the course of years. On scraping off the top layer of undecomposed leaves, one finds such quantities of small roots feeding right at the surface that one's immediate impression is that the forest is eating up its humus as fast as it deposits it. Pines would quite likely be better if *Pinus halepensis*, for instance, were found to succeed under the conditions, but the Chirinda type seems very effective in preventing wash and in preserving coolness and moisture and a perpetual flow from its springs, though they sometimes get low in a drought.

If I should be successful, personally, in aiding the re-afforestation, begun by nature, of the slope referred to, or the forest-advance itself, in the manner I have just suggested, it is possible that I may yet offer the Association a paper on "The Replacement of Wooded Pasture-land by High Forest!"

In conclusion, it may be said, I think, that this type of forest, while primarily dependent on rainfall, has elastic requirements even in that respect. Miss Gibbs gives the range 61-158 inches for another sub-type of the same general formation, and here we may put the minimum as low, I think, as 40 inches: possibly a good deal lower were it not for the more wholesale damage that would then be done by fires. Above a certain figure, varying doubtless with various factors, and with no

strongly-marked dry season, it would appear that this forest gives place, after its destruction for cultivation and the subsequent abandonment of the ground, to secondary forest more or less dense, which becomes largely replaced in time by the original forest. Below that figure, and with a sufficiently strongly-marked dry season, annual fires take place outside the forest, and the latter, as it is destroyed by them or by cultivation, is replaced by grass land, of fire-bearing grasses, intermingled throughout great areas with a secondary type of wooding which is also pyrophytic. This is very different, apparently, from the secondary type in the other class of area, and to be regarded as intervening between it and the primary type; for an equivalent to what is elsewhere the secondary type occurs here as a third stage, should fires cease. The latter is at first partly a matter of the denser massing of the pyrophytic trees themselves, but it is chiefly composed, eventually, of shade-bearing species that belong neither to the true forest nor to the pyrophytes. Where these thickets, or the secondary pyrophytic bush, are near enough to true forest to receive seeds from it, they are eventually swamped and replaced by it—fires still not taking place.

One other point is perhaps of some importance. Our *retreating* forests of to-day are surrounded by graduated zones, varying in width with circumstances, that might be called *denudation-zones*, should we accept wash as the chief factor in the impoverishment that follows forest—though native cultivation and burning contribute strongly—or, better, perhaps, *humus-zones*. When the forest was still unbroken, but was already retreating before the fires, these zones would have existed as continuous lines or concentric rings along or round the whole forest area, and even the inner lines would still have been continuous for some little time after the forest became broken through, while the outer zones may be regarded as still connected to-day. As the fragments became more numerous and widely-spaced, various complicating factors will have arisen. Members of a particular zone will have persisted far longer in some circumstances than in others; the inner zones will not only have surrounded forest-patches, but have survived them for a time as islands, or, should the forest have advanced again, have disappeared through being swallowed up in it, and changes, through silting, etc., in the distribution of the richer elements of the soil will have led to much displacement. Allowing for all this, I believe that a fuller realization of the former continuity of forest and the consequent extension of the zonal idea to embrace these sub-divisions of some of the altitudinal zones, dependent not merely on altitude but on degrees of soil-impoverishment following the destruction of forest sub-divisions, will give us the correct basis for a study of distribution, as well as for our more local œcological studies, faunal and floral. Thus it is highly suggestive that in the Chirinda region our connections with Kilimanjaro, both in birds and plants, extend to several of

the inner grass zones, and—to take a more local point—it is interesting to find that animals—the "blue-buck" (*C. monticola*), the elephant-shrew (*Petrodromus tetradactylus*)—many butterflies, and such birds as *Anthreptes hypodilus*, which on Chirinda's northern outskirts venture only a few yards outside the forest, and might well be regarded as purely forest, or at most (like the *Anthreptes*) outskirts animals, range to the south of Chirinda over a grass-jungle tract (the Jihu) that is nearly 20 miles wide. The fact is that the innermost humus zones, narrowed to the north by the circumstance that the forest has for hundreds of years held its own there while the slope outside it became denuded, to the south still cover the large extent of country mentioned.

There is this difference between these zones and those that are dependent on altitude: that, while the inner higher altitudinal zones have doubtless spread out during periods of glaciation, mountain forest replacing lowland forest and itself in places being squeezed out of the country, yet it has been able to regain the lost ground when milder conditions returned. But its replacement by the grass-veld zones, or whatever civilized man may yet substitute for the latter—let us hope not desert!—will probably be, for the greater part of the area concerned, final—till man disappears.

Addendum.—Mr. J. M. Sim's paper—of great practical interest—on "The Modification of South African Rainfall" * reached me to-day, and, as it bears directly on some of the points I have discussed, I add this note. He proves the disappearance of great forests in the Cape at, I judge, a vastly more rapid rate than may be seen here, but this, I take it, has been in the main the result of the white man's presence. He shows also that, in the Cape, drought conditions, brought about by man, have distinctly to be reckoned with as a direct factor in forest destruction, and though such conditions have not, I believe, acted thus here, yet they may have done so in our lesser rainfall areas to the west—*if the results were not anticipated by fire*, which they probably commonly would be where fire was already annual and the forest unprotected from it. Mr. Sim's remarks on the stag-horning of isolated trees also show clearly that my statement as to the apparent independence of the massed condition enjoyed by our forest trees does not apply to the same type of tree under a much reduced or modified rainfall. Here I know of one or two splendid isolated mahoganies, last survivors of their patches, but now protected from fire, that are in perfect health in spite of their isolation.

I doubt, myself—rashly, for I have no personal acquaintance with them—whether Mr. Sim is quite right in supposing that the Hottentots were kinder to the forests than the Kaffirs have been—excepting where the Kaffirs have also felled or ringbarked for cultivation. Hunting is quite as great an incentive

* *Rept. S.A. Ass. for Adv. of Science*, Maritzburg (1916).

to grass-burning as the wish to cultivate, and here (especially, of course, in the less settled parts) great ring fires are lit annually by the natives for the express purpose of hemming in the contained game, which either breaks through and is shot at or speared—or is burnt. I have known both koodoos and sables to be caught and killed by the flames, in one case quite a number; and these fires, as also fires lit for purposes of rat-hunting, often involve considerable pieces of country. I should expect that hunting man will have used this method ever since he knew the use of fire and found himself in grass-veld.

The paper on the Melsetter trees and shrubs, read in 1916, and several times referred to here, remains unpublished owing to my indisposition. In it I suggested the terms "pyrophyte" and "pyrophobe," here used, for trees adapted to withstand fire, and not so adapted, respectively, and gave in detail the succession of pyrophyte associations that here follows the destruction of forest.

(*Read, July* 4, 1917.)

NOTE ON THE MICRO-TITRATION OF ARSENIC.

By Henry Hamilton Green, D.Sc., F.C.S.

(*Abstract.*)

(*Printed in Annual Report of Director of Veterinary Research, Pretoria.*)

The difficulty of determining small quantities of arsenic in physiological material with any real approach to percentage accuracy is emphasized, and it is pointed out that for quantities ranging from a milligram or two down to one-twentieth of a milligram a micro-titration method is much more serviceable than the commonly used Marsh mirrors or Gutzeit papers. A method is described in which the arsenic is brought over as arsine in the conventional way, collected in dilute silver nitrate, and titrated directly with $\frac{N}{495}$ iodine (1 c.c. = one-tenth of a milligram As_2O_3) after addition of a little bicarbonate and sufficient potassium iodide to keep all excess silver salt in solution. Comparison is made with the reports of referees in the most recent trials of the methods favoured (for food-stuffs) by the Association of Official Agricultural Chemists in America, and it is maintained that micro-titration is more reliable and more rapid than colorimetric determination; that it requires less personal attention to detail, and is applicable in a great many cases where most chemists now adopt a modified Gutzeit method.

(*Read, July* 4, 1917.)

THE VITAMINE CONTENT OF MAIZE AND MAIZE-MILLING PRODUCTS, AND THE AMBIGUITY OF ITS CORRELATION WITH THE PHOSPHORIC OXIDE CONTENT.

By Henry Hamilton Green, D.Sc., F.C.S.

(*Abstract.*)

(*Printed in the Annual Report of Director of Veterinary Research, Pretoria.*)

The examination of maize-milling products by dietetic experiments, using the pigeon as discriminant, indicates that the distribution of vitamine in the maize kernel follows the distribution of phosphoric oxide whenever any given sample of grain is taken into consideration. This parallelism, however, does not hold between different samples of grain, and in a series of samples of whole maize varying in $P_2 O_5$ content from 0.35 per cent. to 0.71 per cent. no difference in vitamine content could be detected by pigeon analysis. In these samples the "indicator limit" of phosphoric oxide, for milled meals on the border-line of efficiency, would vary from 0.23 per cent. to 0.46 per cent. It is therefore impossible to use phosphoric oxide in milled products as indicator of vitamine efficiency unless the phosphoric oxide content of the original mother-grain is known. This information is rarely available, and the determination of $P_2 O_5$ as a general analytical guide to efficiency, as advocated by Voegtlin, Sullivan, and Myers, is therefore ruled out of court. Their standard of 0.5 per cent. $P_2 O_5$ for maize flour would condemn more samples than it passed, and would condemn the majority of perfectly efficient South African meals. Simple microscopic examination of a meal, to gauge the extent of milling, would be a safer guide than the $P_2 O_5$ standard.

By taking "average pigeon requirements" as standard for comparison, and stating this as 100, it is possible to assign "vitamine indices" to any given diet. On this basis whole maize works out at about 160 to 180—*i.e.*, contains over 60 per cent. more vitamine than is actually required in metabolism—and whole maize can therefore stand depletion of vitamine (or $P_2 O_5$) to the extent of about one-third before deficiency is likely to be manifested. The following vitamine indices represent determinations on an average series of milling products to an estimated accuracy of about 10 per cent. either way:—

Product:	Whole Maize.	Fine Meal.	Seconds.	Bran.	Hominy Chop.	Samp.
Vitamine Index	160	120	170	180	380	30

The actual value in any given case depends, of course, upon the mode of milling. The average fine meal is not deficient. The more highly milled high-class table products and breakfast foods (Fanko, etc.), are almost invariably highly deficient, and

their vitamine indices may vary from the border-line 100 down to 30. Since, however, these products are more expensive, and only used by white people living on a mixed diet, their low vitamine content is of minor importance. All samples of mealie meal as ordinarily milled for native consumption were found to be perfectly efficient, with vitamine indices ranging round 130 to 140. The mode of cooking maize meal for native consumption is also discussed, and the bearing of the various data offered in the paper is considered in relation to the possible incidence of deficiency disease on the Rand.

(*Read July* 4, 1917.)

THE SUPPLING KILN AS A MEANS OF DESTROYING INSECTS BORING IN WOOD.

By Charles William Mally, M.Sc., F.L.S., F.E.S.

(*Not printed.*)

OPPORTUNITIES FOR THE SELECTION AND BREEDING OF DESIRABLE STRAINS OF BENEFICIAL INSECTS.

By Charles William Mally, M.Sc., F.L.S., F.E.S.

(*Not printed.*)

NOTES ON ANHYDROUS LIQUID HYDROCYANIC ACID AS A FUMIGANT.

By Charles William Mally, M.Sc., F.L.S., F.E.S.

South African Shells.—In the course of a report on the availability of shells in South Africa for use in the manufacture of buttons, Prof. J. D. F. Gilchrist remarks that no South African shells are gathered for commercial purposes except those which are burned for lime, and those of the *Argonautæ,* which have a small sale as ornaments. The only marine shells which are likely to possess commercial value are the "klipkous" (*Haliotis*) and the Cape pearl oyster (*Margaritifera*). Dr. Gilchrist sent specimens of these shells to London many years ago in order to ascertain their commercial value, but the price quoted would hardly defray the expense of collection. It might be, however, that a more favourable report would be given if a consignment were sent to the United States. These shells, more especially the first-named, could be gathered in quantity, and a report from American shell experts would be of great value, and might lead to important developments.

SOME CENTRAL AFRICAN FOLKLORE TALES.

By Rev. JOHN ROBERT LEWIS KINGON, M.A., F.R.S.E., F.L.S.

There are so many languages and dialects in the Bantu group that no one man can expect to be master of them all. Some strange chance, or opportunity, may put material into the hands of a collector who is himself unable to make full use of it, and consequently there may be danger of losing that material for all time. On the other hand, the mere fact of publication may be the means of placing that material before someone who is qualified to complete the work. It was with this thought uppermost in my mind that I have been induced to place on record a number of Central African Folklore Tales which recently came into my possession. As any experience and opportunities which I have had hitherto have been confined to the southern parts of the African Continent, and remembering that the Bantu group (as the Rev. W. A. Norton told us at the Maritzburg meeting in 1916) comprises 182 languages and 119 dialects, no one will be surprised if I disclaim knowledge of the Central African language in which the following tales are written. This, then, will account for possible errors of grammar, spelling, and punctuation, which may be detected by the expert eye. The main thought in thus recording the tales was to save them from being forever lost, so that, however imperfect they may be in grammatical details, some later worker may be enabled to correct them and translate them.

The tremendous upheaval caused by the campaign in German East Africa, with all that it has meant of disturbance to the native tribes in those regions, the dispersal of tribes, the mixing up of tribes, the change of locality, the flood of new ideas concerning the white man and his ways as exemplified by the British, South African, Belgian, Portuguese, and German troops, with their varying standards of morality and everything else; not to mention the strange men from India, the motor cars, and big guns, and maxims, and aeroplanes, and all the paraphernalia of war—all these things are calculated to create the profoundest disturbance to the native mind, and so lend cogency to the argument in favour of recording these tales ere they are lost, or hopelessly corrupted with the impact of more modern events.

I am indebted to Mr. A. C. Scott, of Port Elizabeth, from whom I have received these stories. It appears that so long ago as 1896 he was a missionary of the Scottish Church, and being stationed at Bandawe, or thereabouts, was able to secure them. They are therefore quite uncorrupted by the recent events connected with the German East Campaign, and may be relied upon. I have already made several efforts to get the tales translated, but thus far without success. However, I am hoping that when once they are in printed form it will be more possible to induce some friend who has the knowledge to complete the work. In the meanwhile they are at least recorded in a safe place.

1. *Indaba Yomuntu Nomntwana Wake.*

Umuntu wahamba ukutima nomntwana wake lapo wahamba futi futi, kodwa indhlala kadi inkulu kadi wadhla inhlamvu zemiti watata futi futi wapa umntwana wake njaro njaro. Kwati ngolunye usuku umntwana wasuta watata inye inhlamvu wabeleta imhlanu wake, wati lujise ebona loku wati hamo wena mntwana mjenza njaro ngani na ? uyabona ukuti indhlara ikona, wena utata inhlamvu ubeleta imhlana, watata mjise warjidhla, kodwa umntwana wakala waya wahlala emutini umuti kadi ngitshihlahla etshinsinyane. Kodwa itshihlahla kadi tshikula lapo uyise wake wabona njaro ukuti itshihlahla tshiyakula watata inhlamvu iziningi wapa untanake. Kodwa umntwana wahala kakulu ngitshihlahla tshakulu tshaba tshide kakulu umntwana uhlezi pezulu. Naye mjise wake wakala lapo wabona itshihlahla tshiyakuba nomntwana upezulu kwatsho itshihlahla, mjise wake walinga ukwenza intambo ende ukuti wamdonsele pansi umntwana wake tshayala itshihlahla wamema abantu abaningi ukumsiza. Kodwa itshihlahla tshaza tshakuba tshafika pezulu, njaro wahamba pezulu kwentaba ukuti wambose umntwana wake itshihlahla tshahulu lapo itshihlahla tshaba tshide umoya wapepeta itshihlahla tshawa pezulu kwelitshe umntwana wafa. Kodwa abanye abantu bamhleka bati, bona peza wayakera ukupata kahle umntwana wako bona peza bamhleka kakulu. Kodwa wahamba wazibopa wafa. Inkosi yabo yati memeza ni muti loku indhlala inkulu loyo oyakupata. Halu umntwana wake lapo mufuna izitero zemiti tiyazi tizobona yakuluma njaro inkosi. Abantu bahlakampa bati atipate kahle abantwana betu injaro indaba leyo.

2. *Indaba Yomuntu Indoda Kwakukona.*

Umuntu watata umfazi waki Babaka undhlu yabo kadi kunomntwana pakati kwe ndhlu yabo. Kodwa umntwana wahamba ukuzingera, walara izinsuku ezuningi ehlatini kwati, unina wagabana nendoda yake wati nguwe yise umtumileyo umutwana, ukuhamba ukuzingira. Indonda yatukutera yati nizomburara loyu mfazi wati ngati nimbulalera lapa ekaya abantu bazaniburara nami wamyenga umfazi wake wati atihambe tiyoteza izinkuni bafika ehlatini. Babona umuti uyomile wakwera umfazi indoda yayima pansi lapo umfazi wagamura ulukuni pezulu kwomuti naye indoda iyagamura pansi umfazi wabeka endodeni pansi nayo indoda yabeka pezulu komuti lapo umunti ufuna kuwa kwafika kanyoni kati yekera ukuwa kanbi kayenza. Njaro lako kanyoni ngumntwana wake loyo kadi wayozingera, akanyoni lapo kafuna ukuhamba umuti ufuna kuwa kafika kati kumuti yimayima uyise awayazanga ukuti lako kanyoni nguye umntwana waki wagamura uyise naye umfazi wake wagamura. Kodwa lako kanyoni kafika kamluma iliso uyise kalikoku lapo uyise wakoka ilizembe ukuti watshaye akanyoni kafika njaro kaluma elinye iliso wawa pansi wafa. Wayehlika unina emutini kanyoni kaba umntwana kalinyera kunina wake unina wake wati yebo mntwana wami unilamlere.

3. *Indaba Inja Ne Mpisi.*

Kwati : Impisi ne yisya kadi bahlala ndawonye kwati Ngolunye usuku bahamba ehaya ukubamba izinkuku. Inja yabona ukuti umbaso

ukona ekaya yati Po mina mya godola neligqwa izinkuni zikona ehlatini tina ati, pembi umbaso. Yahamba yatshera abanye ukuti umbaso ukona ekaya tina tiyagodola lapa ehlatini atilinge ukubaleka tihambe tihlale nabantu zabaleka izinja zahamba ekaya zapika kubantu zati atihlale tonke bahlala nazo abantu. Kwati impisi inye yatsho kweyinye nguwe awahamba nomuntu wako ekaya ngako wahonile abantu ekaya Banawo umbaso ngako unomlanda nati. Kwati leyo, impisi eyahamba ekaya yati yekelani ukukala lina zinini zami babinda yati nizolinga nibambe ekaya nilinge ukubamba inja umuntu wami yayenza. Njaro impisi yabamba ekaya yazingera yaza yakandana ne mja yabanjiwa inja ne impisi yahamba nayo kwezinye izimpisi, lapo izinye izimpisi zabona njaro nazo zahamba ukubamba izinja nguwo umlandu wezinja nezi mpisi tshokona bayanyanyana.

4. Indaba yomuntu umzingeri loyo muntu wahamba futi ukuzingera izinja mazana waburala izinyamazana ziningi kwati ngosuku lunge wahamba yedwa ukuzingera izinyamazana wazikanda ziningi Izindhlovu, kodwa lapo Izindhlovu zambona zati atipenduke inkawane zayenza njaro umuntu loyo wanyenya uqonda ukuti mijohlaba zona lapo wafika eduze wakonda inkowane, wati aniqale nisipune. Inkowane wasipuna wahamba wanyenya waqonda Izindhlovu zikona Lapo wafika eduze wakonda kuze Izindhlovu watsho pakati kwenhliziyo wati loku Izindhlovu zibalekile anihambe niyopeka inkowane yake wayawafika etshikodhlweni wabeka imbiza ezikweni lapo watata inkowane ukuti nibeke embize ni kupeka yona. Inkowane yapenduka yaba Izindhlovu. walinga ukubaleka kodwa zamba mba zagijima naye umuntu loyo zihamba naye kona ekaya lake zihamba zivuma Ingoma ziti Lilibambile iqili elatiqeda zaya zafika naye ekaya kubo lapo abantu bambona upezulu komhlana wezindhlovu bapuma bamlandera ukuti bamtate kodwa lapo bafika eduze bakanda ngimizi yabantu Izindhlovu zapenduka imizi kwaba abantu pakati lkewzindhlu Batshuleka babuya ekaya labo bayalira. I Njaro indaba yomuntu awahamba yedwa ukuzingera.

5. *Indaba Yomuntu Omndala.*

Kwati umuntu omndala kadi waze ukudhla wahamba emhlanjeni ukuqipa izimbeba wahamba futi futi emhlanjeni wahamba watata izimbeba ekaya wadhla ngosuku lunye wahamba emhlanjeni owukulu wakanda. Abantu bayalima kadi banabantwana wafika wati loku mina ningu ndala mina *aniondhle* umntwana wenu munikokele ukudhla Bamupa umntwana wawondhla, wayenza njaro futi futi ngosuku lunye watata umntwana wahamba naye waya wangena elitsheni wahlata kona. Abanikazi bomntwana lapo babona umuntu kuze ukufika nomntwana Bamlandera bamkanda elitsheni uyangena naye umntwana bamemeza betu tisizeni tina bakiti nangu umuntu wafika kutina watatile umntwana wetu wangene naye elitsheni babuya abantu abaningi namakuba namazembe ukuyimbai litshe bayimba nokuyamura bakanda amazembe namakuba ayapuka kodwa kwafika umfani loyo. Kadi ngumhambi wati nilisize mina batsho yebo tisize waqipa itshipingo wati

kubo sukani kaloku kuhlale kutulile basuka bonke kwatuly loyo muntu wabona kutulile wallnga ukupuma lapo wapuma wabanjwa nomntwana usezandhleni zake lapo batuma munye ukuyakubona wabona ubanjiwe nomntwana usezandhleni zake wagijima waya wabika bapuma bonke abantu bamkanda bamtata umntwana bahamba naye Babonga umuntu owabasiza a bona.

6. *Indaba Yezimyamazana.*

Izinyamazana zamemana zonke zabutana ndawonye. Inyati yati kuhle tibofihlama titume omunye ukukanda ofihlemeyo kwaba. Njaro yahamba, Indhlovu ukufihlama batuma, Impofu ukukanda, Indhlovu yahamba Impofu yakanda, Indhlovu yati nguwe. Indhlovu yapuma kwaba njaro inye yahamba zatuma inye ukukanda efihleme yakandiwe, njaro njaro ezinsuku zonke zayenza njaro zaza zapera zonke izinyamazana ezikulu ukufihlama. Kwati ngosuku lunye uqakide wati mina ngati nifihlama kuti munganibona aike Izinyamazana zati zonke erere mfana tina tiyahluleke ngani? Loku wena nguwe mfana, kodwa uqakide wati niyekeleni nilinge.

Wahamba uqakide wafihlama ekufihlameni kwake waha wayimba endhleleni wapakamisa ilikanda namazinyo apezulu umzimba upasi kwomlindi. Izinyamazana zatuma inhlangu. Lapo, inhlangu yahamba yabona endhleleni amazimpo akona yayetuka yamameza. Qakide bona ilizwe lihlime amazinyo yahamba yagijima yaluza ezinye zabuya zonke zimemeza ziti Qakide ilizwe lihlume amazinyo. Kanti aziyazi ukuti nguye u Qakide zasabe kakulu zahamba ukuhlahluma azikandanga itshisusa ukuti nguye u Qakide.

Kwati zisakuluma Indaba wafika u Furu wati mukuluma ni lina zinyamazana, Kodwa zapendura zati ilizwe lihlume amazinyo wati u Furu tihambe tibone Bahamba wafika kona u Furu wati nguye u Qakide ofihleme lapa, wapuma u Qakide Izinyamazana zonke zamangara zati ulungile u Furu zatokoza yapera indaba yokufihlama.

NOCARDIA CYLINDRACEA: A SOUTH AFRICAN OTOMYCOSIS.

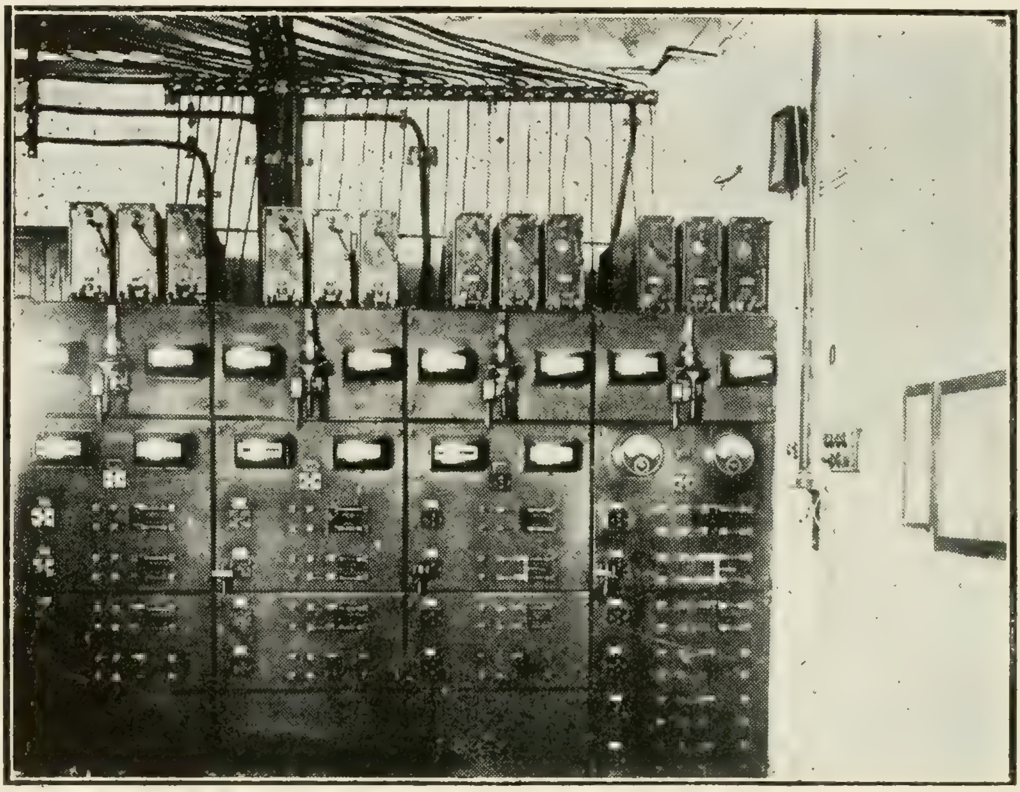
By William Edmond de Korte, M.B., M.R.C.S., L.R.C.P.

(*Not printed.*)

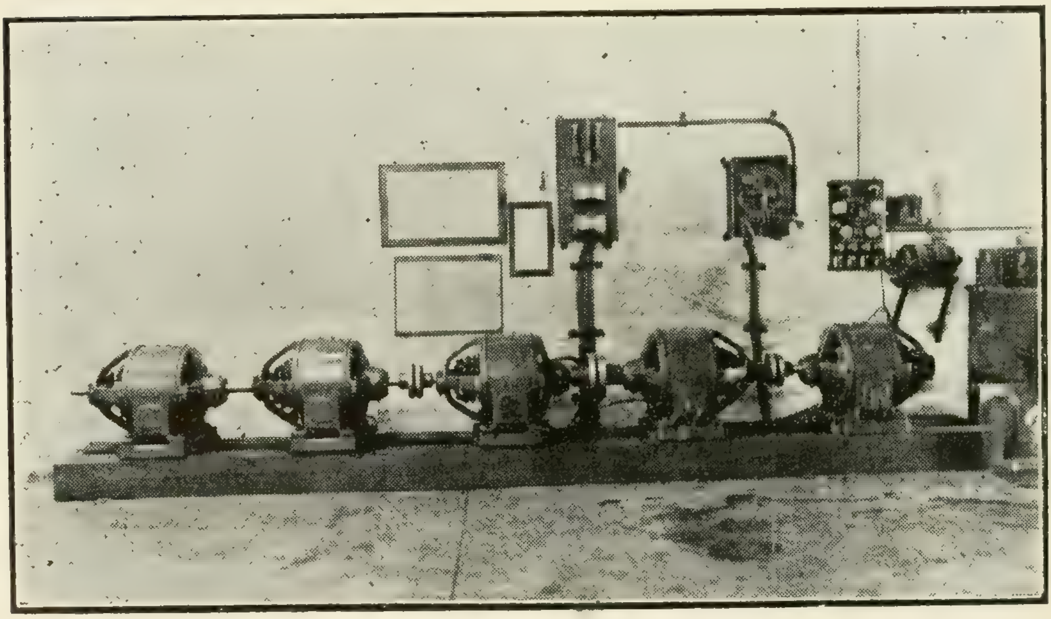
NEGLECTED ASSETS OF EMPIRE.

By Mrs. Julia F. Solly.

(*Not printed.*)



a.



b.

J. W. Kirkland.—An Electric Vehicle Charging Plant.

AN ELECTRIC VEHICLE CHARGING PLANT.

By John Wilkinson Kirkland, M.Am.I.E.E.

(*Plates* 18-19 *and one text figure.*)

The purpose of this brief paper is to describe and illustrate a successful and economical charging plant for electric vehicles which has been installed at Johannesburg. It is believed that this is the largest electric charging station south of the Equator. No general or specific arguments as to the economy of such vehicles are advanced, but the practical arrangements of charging apparatus and control are dealt with.

The problem was to design and build from materials locally available apparatus which would enable a large number of electric vehicles to be charged simultaneously by means of the 460-volt direct current municipal supply. The largest vehicle planned for requires for charging 75 ampères at 115 volts, and the smallest 37½ ampères at 60 volts.

It was decided to instal a 4-unit balancer set consisting of 115-volt direct-current shunt-wound generator, and to derive from this machine four 115-volt circuits. The set as erected is shown in Plate 18*b*. Each machine is rated at 12½ kw., and the speed is 800. (The fifth machine, on the left, is a spare, and is not connected up either mechanically or electrically.) These four machines as originally furnished had shaft extensions at one end only. It was necessary, therefore, to weld extensions to two of the shafts, and this was successfully done by the electric arc process. The machines are connected by flexible couplings of the leather strap type, and are mounted on a heavy timber base. A single starting rheostat, with low voltage release, is employed, and a direct-current circuit breaker protects the set and the system from overload. An ammeter (300 ampères) and a voltmeter (750 volts) are also provided, as may be seen in the picture.

All of this apparatus is installed on the first floor of the charging garage, and heavy insulated circuits are run thence to the ground-floor, where there is a distribution and control switchboard. This board was built locally in Johannesburg, and has four main sections, three of which are now equipped for four circuits and one for six circuits. When required the board can be completed for 18 circuits by adding switches for two more circuits on each of three of the sections. Plate 18*a* shows the general arrangement and appearance of the board.

Fig. 1 is a general wiring diagram of the balancer set and switchboard. Each of the four 115-volt circuits derived from the balancer is connected to busbars through a reverse current overload circuit and through a main ammeter. A voltmeter also shows the busbar voltage. Immediately below these main instruments are the circuit ammeter and voltmeter, one of each being sufficient to care for all of the circuits in the section. This is

accomplished as regards the ammeter by using double-thrower lever switches, and, as regards the voltmeter, by means of potential plugs and receptacles. These circuit instruments enable the operator to ascertain at any time the voltage and current supplied to any battery under charge. There is a series rheostat for each circuit for regulating the charging rate. These are easily manipulated by a rod from the floor level.

Plate 19*a* shows the charging circuits fastened to the garage ceiling, and also a number of vehicles on charge.

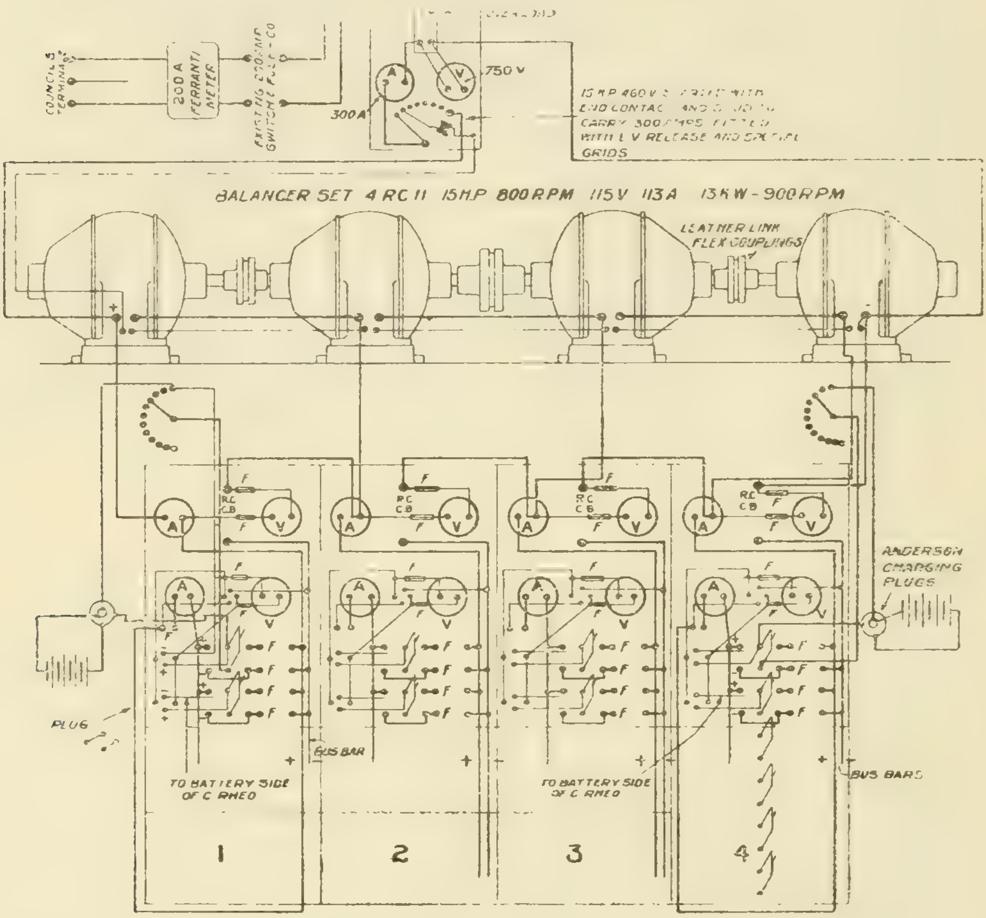
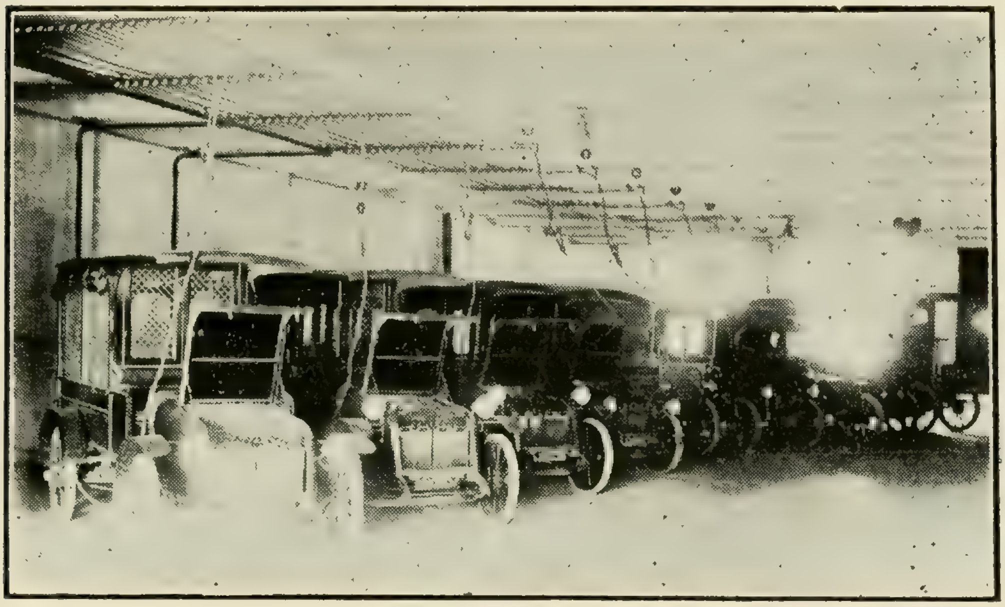


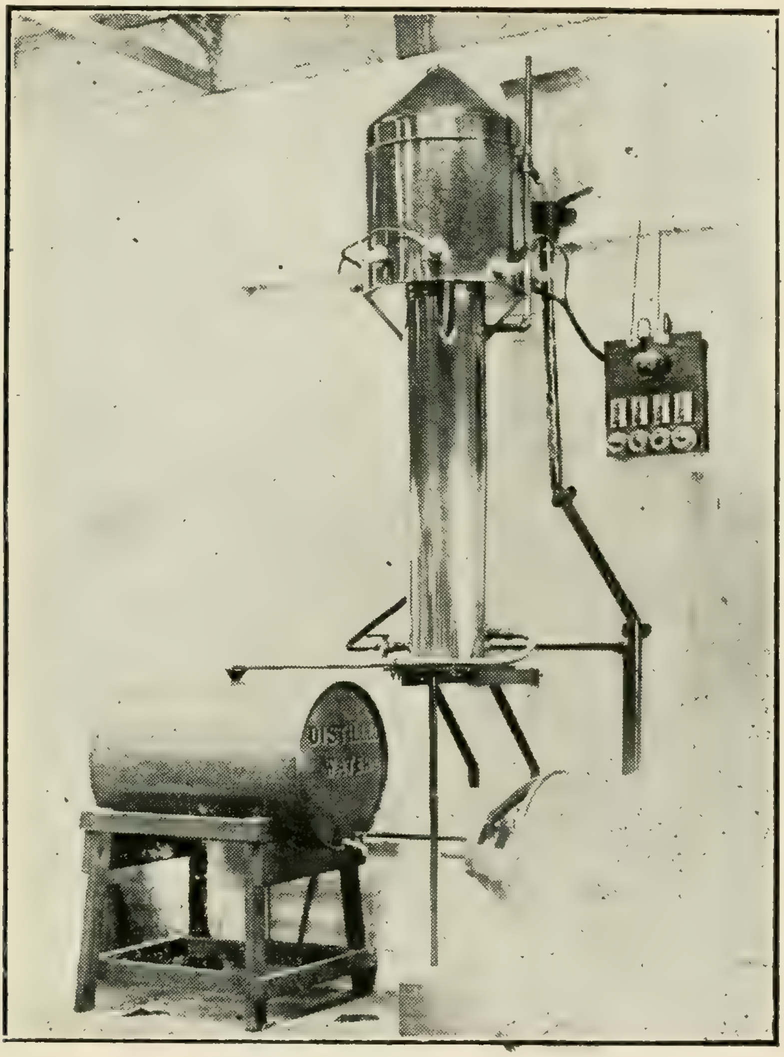
Fig. 1.

The advantage of using a balancer set is that its units need be no larger than the requirements of the largest vehicle to be charged. That being so, it is exceedingly efficient in operation.

Plate 19*b* shows an electrically-operated still (also of local design and manufacture) for producing the water necessary for the storage batteries. It is equipped with eight 1,000-watt heating units. These are wired in four sets of two in series on 460 volts, each pair being controlled by a snap switch. The capacity is about two gallons per hour, and after once being switched on and the inlet cock adjusted to give the best relation of cooling water to the product, it requires no further attention. The still is of sheet copper, thoroughly tinned on all surfaces in contact with the water. Its operation has been highly satisfactory.



a.



b.

J. W. Kirkland.—An Electric Vehicle Charging Plant.

ARS SOPHOCLIS INTERPRETANDI: WITH SPECIAL REFERENCE TO THE TRACHINIAI.

By Hendrik Geldenhuys Viljoen, B.A., D.Litt.

The task of the textual critic is twofold: (1) recension and (2) emendation. In the case of our author, Sophokles, our recension is about as complete as possible, for the present at least, unless the sands of Egypt have still a surprise in store for us. Lately the Indagatores of Sophokles was found in Egypt, and we may cherish the hope that more of Sophokles' works may come to light.

With respect to emendation, much must still be done for Sophokles. It is not only a question of emendation, but very often a question of interpretation. From what I have seen of emendation, it appears to me that scholars are too apt to rush into publicity with the most impossible emendations. Boeck, the founder of the idea of the Altertumswissenschaft and the great rival of Godfried Hermann, whom Goethe styles the aristocrat of classical philology, has aptly said: "Im Allgemeinen kann man behaupten, dass von 100 Conjecturen, welche die Kritiker machen, nicht 5 wahr sind."

In the case of Sophokles this is, according to my experience, quite true. In the first three instances I have attempted to show that the hand of the emendator is not required. It is a case of interpretation. In the other passages I have tried to point out that the accepted remedies are too violent. The physicians have either applied the remedy in the wrong place or they have entirely ignored the diagnosis, which in the case of textual criticism depends upon a first-class knowledge of paleography and the various errors into which the scribæ dormitantes fall.

Trachiniai of Sophokles 674 *sqq.*:

ᾧ γὰρ τὸν ἐνδυτῆρα πέπλον ἀρτίως
ἔχριον, ἀργῆς οἰὸς εὐέρου πόκος,
τοῦτ' ἠφάνισται, διάβορον πρὸς οὐδενὸς
τῶν ἔνδον, ἀλλ' ἐδεστὸν ἐξ αὑτοῦ φθίνει,
καὶ ψῇ κατ' ἄκρας σπιλάδος.

Jebb, in his note to v. 678, says:—"ψῇ is not elsewhere intransitive (cp. 698), and hence has been suspected here . . . . κατ' ἄκρας σπιλάδος, down from the top of a flat stone, or slab, in the αὐλή of the house. Schol.: ὡς οὖν ἐπὶ λίθου θεμένη αὐτὸ τοῦτό φησι. On coming into the courtyard from the room

in which she had secretly anointed the robe, she had carelessly thrown the tuft of wool down upon this stone. Such is the only sense which the words will bear. They are perhaps corrupt. Sophokles has the dat. plur. σπιλάδεσσι, in the ordinary sense, "sea-rocks," in fr. 341 ; but the sense of the sing. here is peculiar . . . . Possibly the true reading is κατ' ἄκρας σπόδιον, "utterly pulverised," and σπιλάδος arose when the letters after σπ had been partly effaced, through the wish to find a subst. which could agree with ἄκρας. Cp. Sind. κατ' ἄκρας· δι' ὅλου, παντελῶς: and O.C. 1242 (ὡς καὶ τόνδε κατ' ἄκρας | δειναὶ κυματοαγεῖς ἆται κλονέουσιν ἀεὶ ξυνοῦσαι)."

And he translates : "That with which I was lately anointing the festal robe,—a white tuft of fleecy sheep's wool,—hath disappeared, not consumed by anything in the house, but self-devoured and self-destroyed, *as it crumbled down from the surface of a stone.*"

He accordingly takes ψῇ as intransitive and σπιλάδος as agreeing with ἄκρας. σπιλάς is an Homeric word. It is found only in the Odyssey, ε 405 we have σπιλάδες : ε 401 σπιλάδεσσι and γ 298 σπιλάδεσσιν, according to the Index Homericus of Gehring and Ebeling's Lexicon Homericum.

Ancient Homeric critics and lexicographers were not quite sure whether the rocks were to be placed along the coast or in shallow water. Ap. 144, 7, says : ὁ μὲν Ἀπίων αἱ ἐν ὕδατι κοῖλαι πέτραι, ὁ δὲ Ἡλιόδωρος αἱ παραθαλάσσιαι πέτραι καὶ πεπιλημέναι ὑπὸ τῶν κυμάτων.

Hesychios says : αἱ περιεχόμεναι τῇ θαλάσσῃ πέτραι.

In Apollonios Rhodios Γ 1293 *sqq*. we have :

αὐτὰρ ὁ τούσγε,
εὖ διαβάς, ἐπιόντας, ἅ τε σπιλὰς εἰν ἁλὶ πέτρη
μίμνει ἀπειρεσίῃσι δονεύμενα κύματ' ἀέλλαις.

As a rule we talk of sea-rocks in the plural, but it is clear that we can have the singular when one sea-rock is meant.

Jebb's objection to the singular in our passage is therefore groundless.

Dindorf-Mekler, the editors of the Teubner-text of Sophokles, say : Nondum expeditus : requiritur quale quid Froehlichius temptat καὶ ψήχεται κατ' ἔδαφος.

But I hold that our text is sound here. ψῇ is not used intransitively ; its object is σπιλάδος, which is the genitive of the part. It is strange that no French critic has detected the use of the genitive of the part here, as the French language shows the same affinity. σπιλάς is perhaps a flat stone with which the courtyard

was paved. Sophokles does not ask his audience to believe that such a large stone was entirely corroded by the tuft of wool. Only the part that came in contact with the wool entirely vanished. *κατ' ἄκρας* has the same meaning as in O.C. 1242 and as explained by Suidas. Translate : " and it entirely corroded a part of the stone " and not : " as it crumbled down from the surface of a stone."

Ibid. 868.

> ξύνες δὲ
> τήνδ' ὡς ἀήθης καὶ συνωφρυωμένη
> χωρεῖ πρὸς ἡμᾶς γραῖα . . . .

In his note Jebb says : The MS. reading, ἀήθης, cannot be right. The word means either (1) " unusual " or (2) unaccustomed to a thing. Here it has been taken in the first sense, as meaning, " with strange aspect," " unlike herself,"—*i.e.*, gloomy, instead of cheerful. It seems inconceivable that a classical writer should have so used ἀήθης. Rejecting the conjecture ἀηδὴς he proceeds : Surely ἀήθης was merely a corruption of ἀγηθής, which does not seem to occur, but which is as correct as εὐγηθής or πολυγηθής.

Since the discovery of Sophokles' Indagatores we have more light on our author's boldness of using words. In v. 162 of the Indagatores we find the verb ψοφήσετε which Maas* has shown to have the same meaning as in Modern Greek, viz., " to die like a dog " ; Dutch " vrekken " and German " crepieren." We find διαφωνέω in this sense in the Septuagint and Diodoros, etc. Cf. Sophocles, Byzantine Greek-English Lexicon, s.v.

Furthermore, we have in the vicinity of ἀήθης a number of ἅπαξ εἰρημένα : καινοποιηθὲν (873) ; διηΐστωσε (881) ; χειροποιεῖται (891), etc. In v. 911 we have another instance of our dramatist's bold use of words, as we shall see.

Prof. Ulrich von Wilamowitz-Moellendorff, in his note to Eur. Herakles, v. 269, p. 275 sq. says : Weit kühner sagt Soph. Tr. 196 τὸ ποθοῦν ἕκαστος ἐκμαθεῖν θέλων | οὐκ ἂν μεθεῖτο πρὶν καθ' ἡδονὴν κλύειν. In his note to this verse Jebb says : " I leave τὸ . . . ποθοῦν in the text, not feeling certain that it is corrupt ; though I am disposed to read, with E. Thomas, τὰ γὰρ ποθεῖν'." If τὸ ποθοῦν can mean only " the feeling of desire " I think the error must be sought in ἐκμαθεῖν. In this case I would read ἐκθανεῖν. I hold that τὸ ποθοῦν is sound. The schol. explains τὸ ποθούμενον. Translate : " Everyone wishing his feeling of desire to die away." In accepting τὸ ποθοῦν = τὸ ποθούμενον, ἐκθανεῖν would easily

* *Berl. Philol. Wochenschr.* (1912), **34**, 1076.

become ἐκμαθεῖν to fit in with the sense, and also on paleographical grounds through the metathesis of the letters ΘΑΝ into ΜΑΘ Roberts in his edition of the De Sublimitate, p. 200, s.v. ἦθος says: ἦθος, as contrasted with πάθος was considered a special mark of comedy as distinguished from tragedy. Hence ἐν ἤθει (sc. τοῦτο ἔφη) = "in character" or "humorously" (Rutherford, Schol. Aristophan. II 442; cp. Plut. De Andiendio poetis). De Sublimitate XXIX 2 reads: πάθος δὲ ὕψους μετέχει τοσοῦτον, ὁπόσον ἦθος ἡδονῆς.

The participle συνωφρυωμένη, "with knitted brow" shows that ἀήθης must refer to the countenance and the eyes. For the interpretation of ἀήθης I may cite Philostratos περὶ γυμναστικοῦ XXV, 20. ἄλλα γὰρ μελανοφθάλμων. ἄλλα δε χαρόπων ὀφθαλμῶν ἤθη.—ἡ γὰρ φύσις ὥρας μὲν ἄστροις ἐσημήνατο ἤθη δ' ὀφθαλμοῖς; *ibid.* XXV, 16, τὴν ἐν ὀφθαλμῶν ἠθικήν and XXVI, 15.

Ibid. 907 sqq.

> ἄλλῃ δε κἄλλῃ δωμάτων στρωφωμένη,
> εἴ του φίλων βλέψειεν οἰκετῶν δέμας,
> ἔκλαιεν ἡ δύστηνος εἰσορωμένη.
> αὐτὴ τὸν αὑτῆς δαίμον' ἀνακαλουμένη
> καὶ τὰς ἄπαιδας ἐς τὸ λοιπὸν οὐσίας.

In his note to line 911 Jebb says: "The MS. text, καὶ τὰς ἄπαιδας ἐς τὸ λοιπὸν οὐσίας, is undoubtedly corrupt . . . The genuine verse must have had some direct reference to the context. She is weeping at the sight of attached servants whom she is about to leave." He proposes ΕΠΑΛΛΟΙΣ for ΑΠΑΙΔΑΣ: καὶ τῆς ἐπ' ἄλλοις ἐς τὸ λοιπὸν οὐσίας: "and the fate of the property which would thenceforth be in the power of others." Although the slaves are part of the οὐσία we expect a more direct reference to them.

The Teubner editors cut the knot by deleting the verse.

To my mind the text is sound as we have it. παῖς in Greek means "a slave" as well as "a child." ἄπαις can therefore mean "without children," "unlike a child," or "unslave-like," "without a slave." Compare εὔπαις which means "blest with children" and in Eur. H. F. 689 and I. T. 1234 it means "well-built, noble son." It has the same meaning as καλλίπαις. Compare Eur. Or. 964 περσέφασσα καλλίπαις θεά, and *Ibid.* Phœnissae 1618 ἀλλ' εὔτεκνος ξυνωρίς;

In the passage under consideration ἄπαις is formed like ἄοικος in Soph. Philoktetes 534: ἄοικον εἰσοίκησιν where it means "a dwelling that is no dwelling"—*i.e.*, a miserable, wretched abode

Compare πόλεμος ἀπόλεμος, a war that is no war, a hopeless struggle. Aischulos Prometheus 904: ἀπόλεμος ὅδε γ' ὁ πόλεμος; Eur. H. F. 1133: ἀπόλεμον, ὦ παῖ, πόλεμον ἔσπευσας τέκνοις. And πόλις ἄπολις, a city that is no city, a ruined city. Aischulos Eum. 457: ξὺν ᾧ σὺ Τροίαν ἄπολιν Ἰλίου πόλιν ἔθηκας.

Instead of having παῖδας ἄπαιδας—*i.e.*, slaves that are no slaves, wretched, miserable slaves—we have the bold periphrasis: καὶ τὰς ἄπαιδας ἐς τὸ λοιπὸν οὐσίας: καὶ τὰς (or τοὺς) παῖδας ἐς τὸ λοιπὸν ἄπαιδας οὔσας (ὄντας). The word οὐσίας may have been chosen on metrical grounds,, but its meaning in the sense of pieces of property, *i.e.* chattels, may have prompted the dramatist to use it here. The plural οὐσίαι for individuals we find in Aristotle.

In Sophokles Philoktetes 936-7 we have the periphrasis ὦ ξυνουσίαι θηρῶν ὀρείων = οἱ ξυνόντες θῆρες where we may note that ξυνουσίαι too like οὐσίας in our passage stands at the end of the verse. We may therefore infer that the nouns οὐσίας and ξυνουσίαι were selected on metrical grounds as the quantities of the participles ξυνόντες, ὄντας and οὔσας offered difficulties in iambic verse, especially in the last foot, where a short and long are required. It is remarkable the number of passages we find where οὐσία and the compounds ἀπουσία, ξυνουσία, παρουσία are placed at the end of iambic verses. Compare Aischulos Eum. 285 ὅσοις προσῆλθον ἀβλαβεῖ ξυνουσίᾳ; Soph. O.C. 647; Philoktetes 520; Aristophanes Nub. 649; Thesmoph. 21; Ekkl. 729 προχειριοῦμαι κἀξετάσω τὴν οὐσίαν: Eur. H. F. 337; Hecuba 962: σὺ δ' εἴ τι μέμφῃ τῆς ἐμῆς ἀπουσίας; Aisch. Ag. 1259; Euripides Alkestis 606: ἀνδρῶν Φεραίων εὐμενὴς παρουσία which is a periphrasis for ἄνδρες οἱ παρόντες; Aisch. Pers. 169; Soph. Elektra 1104; 1251; Arist. Thesm. 1049.

These passages show that the iambic ending of οὐσία and its compounds appealed strongly to the dramatists to use these words at the end of verses, especially in cases of periphrasis when the untractable endings of the participles were to be avoided metri causa. The best examples are Soph. Phil. 936-7 and Eur. Alk. 606.

The feminine noun οὐσίας leaves the question open as to the gender. It may be common gender or it may refer specially to the female slaves of Deianeira.

To sum up: καὶ τὰς ἄπαιδας ἐς τὸ λοιπὸν οὐσίας is a bold periphrasis for καὶ τὰς (τοὺς) παῖδας (δούλους, δούλας) ἐς τὸ λοιπὸν ἄπαιδας οὔσας (ὄντας). "And the slaves that are for the future slaves no more, miserable, wretched slaves." And this is exactly the sense required by the context. The difficulty of

interpretation arose when commentators settled their thoughts on Deianeira as a mother suggested by her being ἄπαις, *i.e.* unable to bear children when Herakles had died.

Ibid. 329 sqq.

> ἡ δ' οὖν ἐάσθω, καὶ πορευέσθω στέγας
> οὕτως ὅπως ἥδιστα, μηδὲ πρὸς κακοῖς
> τοῖς οὖσι λύπην πρός γ' ἐμοῦ λύπην λάβοι.

This is the reading of the Codex Laurentianus, with most MSS. It is clear that either the first or the second λύπην in the last verse must be corrupt. Jebb accepts the emendation of Triclinius, the scholar of the early fourteenth century, ἄλλην for the first λύπην. F. W. Schmidt suggested λύπην . . . διπλῆν, which is received by Mekler in the Teubner text. On paleographical grounds, I have a doubt against ἄλλην. The first ΛΥΠΗΝ must have arisen out of ΑΥΤΗΝ. Α and Λ, Τ and Π are easily confused in capitals. The last line would therefore run :

> τοῖς οὖσιν αὖ τὴν πρός γ' ἐμοῦ λύπην λάβοι.

For πρός γ' ἐμοῦ compare v. 738 :

> τί δ' ἐστίν, ὦ παῖ, πρός γ' ἐμοῦ στυγούμενον ;

Ibid. 379 sqq.

> ἦ καὶ τὰ λαμπρὰ καὶ κατ' ὄμμα καὶ φύσιν | πατρὸς μὲν οὖσα γένεσιν Εὐρύτου ποτὲ | Ἰόλη 'καλεῖτο, κτλ.

This is the MS. text. ἦ καὶ τὰ has been changed into ἦ κάρτα by Canter of the sixteenth century. The acceptance of this emendation has led Fröhlich and others (Hartung, Wecklein) to read ὄνομα for ὄμμα. Jebb's text accordingly runs :

> ἦ κάρτα λαμπρὰ καὶ κατ' ὄνομα καὶ φύσιν | πατρὸς μὲν οὖσα γένεσιν Εὐρύτου ποτὲ | Ἰόλη 'καλεῖτο, κτλ.

Reiske (1716-1774) was the first to feel some difficulty about μὲν after πατρὸς for which he proposed γὰρ. Jebb says : "The simplest account of the μὲν is that Ἰόλη δὲ καλουμένη ought to have followed, but, owing to the fact that her name is primarily in question, the second clause became Ἰόλη 'καλεῖτο." So he accepts two emendations and smooths over the difficulty, where I think we ought to look for the word that would restore sense to the whole passage. We shall have occasion to draw attention to the fact that eminent scholars have in other passages followed the same bad principle of emending or accepting emendations intended to bring the sense in line with the only word that is

undoubtedly corrupt without attempting to emend it. This is a very serious flaw in the work of the textual critic.

The only change required in this passage is the simple restoration **μένουσα**, "abiding, awaiting" for *μὲν οὖσα* and the mark of punctuation must be removed after *φύσιν*:

ἦ καὶ τὰ λαμπρὰ καὶ κατ' ὄμμα καὶ φύσιν | πατρὸς μένουσα γένεσιν Εὐρύτου ποτὲ | Ἰόλη 'καλεῖτο κτλ.

φύσιν does not mean "birth" as taken by Jebb, but "form, stature," as used by Sophokles in O.T. 740: *τὸν δὲ Λάϊον φύσιν τίν' εἶχε φράζε, κτλ.*

πατρὸς goes very closely with *τὰ λαμπρά καὶ κατ' ὄμμα καὶ φύσιν*. There is no difficulty with the meaning of *ὄμμα* when *φύσιν* is taken in this sense and *γένεσιν* is not left otiose as it would be according to the view of Jebb. *κατ' ὄμμα καὶ φύσιν* refers to her noble appearance and fine build with which Deianeira was struck. *ποτὲ* by its position shows that it goes with *μένουσα* as well as *'καλεῖτο*. Translate: "Indeed awaiting once the lustre of her father Eurytos as to her appearance and build she was called Iole." She received her name naturally as an infant. As a child she had to grow up still before she could show her full build and appearance. Hence she was awaiting this splendour.

Ibid. 660 sqq.

ὅθεν μόλοι πανάμερος
τᾶς πειθοῦς παγχρίστῳ
συγκραθεὶς ἐπὶ προφάσει θηρός.

So the MSS. For **πανάμερος** Mudge reads *πανίμερος*. For the unmetrical *θηρός* Haupt gives *φάρους*. *συγκραθεὶς* cannot be right, as we require a long, short, long syllable as is shown by *ἔξελυς* v. 653 in the strophe *β'*. For *θηρός* we require a short, long.

Jebb accepts *πανίμερος* on the strength of the meaning of *συγκραθεὶς* which he however obelizes.

Of *παγχρίστῳ* Liddell and Scott say that it stands without a substantive! Schneidewin reads *ἀγκίστρῳ*.

I feel that the substantive with which *παγχρίστῳ* goes is concealed in the corrupt **συγκραθεὶς**, for which I would suggest ΣΥΝΚΡΑΤΕΙΣ—*i.e.* *σὺν κράτει σ'*.

πανάμερος is sound, but it means: quite tame, soft, gentle. This adjective is found in Ecclesiastical writers, but the simple *ἥμερος* is found in classical writers. Here we have once more that Sophokles uses a word that is extant only in late writers.

πανάμερος goes with the genitive **τᾶς πειθοῦς**. If it had not been for the metre there would be some point in retaining *θηρός* as

the *θήρ*, the wild beast, was the means of taming Herakles. The *σ'* refers to Deianeira, as the Choros turns from the third to the second person to address her when she appears towards the close of the ode.

In verses 731-3 the chorus betrays a knowledge of facts that they may have gathered on entering at the close of the prologue that closed at line 93.

These lines therefore run:

ὅθεν μόλοι πανάμερος
τᾶς πειθοῦς παγχρίστῳ
σὺν κράτει σ' ἐπὶ προφάσει φάρους.

"Thence may he come to thee, all-subdued (tamed) by persuasion, with his strength (person) all-anointed on the pretext of the robe."

If it had not been for the metre I would have retained *θηρός*. *παγχρίστῳ σὺν κράτει* refers to Herakles' athletic prowess, as athletes were anointed or rubbed with oil after their exercises.

Ibid. 828 sqq.

πῶς γὰρ ἂν ὁ μὴ λεύσσων
ἔτι ποτέ . . . . . . ἔτ' ἐπίπονον ἔχοι θανὼν
λατρείαν;

In the corresponding line of the antistrophe, 840, the Codex Laurentianus reads:

νέσσου θ' ὕπο φοίνια δολόμυθα κέντρ' ἐπιζέσαντα.

In v. 830 Jebb reads: *ἔτι ποτ' ἔτ' ἐπίπονον* <*πόνων*> *ἔχοι θανὼν λατρείαν*; accepting Gleditsch's conjecture *πόνων* after *ἐπίπονον*.

In the line of the antistrophe the Cambridge editor reads: *Νέσσου ὑποφόνια δολιόμυθα κέντρ' ἐπιζέσαντα* based on Gleditsch.

This view of Gleditsch and his followers I have to reject. His conjecture *πόνων* in 830 is nothing more than a stopgap to emend the metre which he is compelled to change in two places in v. 840. There are three points that go against inserting *πόνων* after *ἐπίπονον*.

In the first place *λεύσσων* is without an object, a construction not found elsewhere. L. has a space of seven or eight letters between *ποτὲ* and *ἔτ'*. This space must have contained the object of *λεύσσων* and the preservation of the *ε* in *ποτὲ* shows that the following letter was a consonant and not a vowel.

I must first consider the metre of v. 840 and the readings before I can decide on the quantities required in the lacuna in v. 830.

I may note a point overlooked by other critics, which shows that Νεσσου is sound and no interpolation.

Some commentator was offended by the hiatus between Νέσσου and ὑποφοίνια, so he inserted θ' after Νέσσου but he compensated the gain of a short syllable in the metre by writing a single σ so as to make the first syllable of Νεσου short. He accordingly had a short, long, short which was equivalent to the two long ones in Νε̄σσοῡυπ.

I therefore consider that line 840 ran: Νέσσου ὑποφοίνια δολόμυθα κέντρ' ἐπιζέσαντα. The first syllable of Νέσσου stands in anacrusis. The metre is then : — υ — υυ υυ — υ — υ — υ — ῡ Taking ἔτι in v. 830 in anacrusis corresponding with the first syllable of Νέσσου we see that we require in the lacuna four short syllables to emend the metre. This must be the object of λεύσσων and the ε of ποτὲ shows that it must begin with a consonant. It must be from seven to eight letters long. This can be either τόδε φάος or τὸ φέγγος. I prefer τὸ φέγγος where the long syllable of φέγγος corresponds with that in ὑποφοίνια.

So the passage runs :

> πῶς γὰρ ἂν ὁ μὴ λεύσσων
> ἔτι ποτὲ <τὸ φέγγος> ἔτ' ἐπίπονον ἔχοι
> θανὼν λατρείαν ;

This gives ἔτι ποτὲ its real force, and shows that the two words ἔτι have their respective work in the sentence.

This sentence corresponds with v. 840 in metre :

> Νέσσου ὑποφοίνια δολόμυθα κέντρ' ἐπιζέσαντα.

Ibid. 841 sqq.

> ὧν ἅδ' ἁ τλάμων ἄοκνον μεγάλαν προσορῶσα
> δόμοισι βλάβαν νέων
> ἀϊσσόντων γάμων, τὰ μὲν οὔτι προσέβαλε·
> τὰ δ' ἐπ' ἀλλόθρου
> γνώμας μολόντ' ὀλεθρίαισι συναλλαγαῖς
> ἦ που ὀλοὰ στένει, κτλ.

Musgrave reads ἄοκνος for ἄοκνον. For ἀϊσσόντων Nauck reads ἀΐσσουσαν. Blaydes suggests αὐτὰ for οὔτι. For ἐπ' ἀλλόθρου L. has a correction ἀπ' ἀλλόθρου which is found in B,K,T. In v. 842 δόμοισι is the reading of Triclinius : δόμοις MSS. Minor corrections are 844 προσέβαλε V : προσέβαλεν L. ; ἀλλόθρου Erfundt ; ἀλλοθρόου MSS. 845 ὀλεθρίαισι Triclinius : ὀλεθρίαις MSS. συναλλαγαῖς Wunder : ξυναλλαγαῖς MSS.

Jebb's text runs :
ὧν ἅδ' ἁ τλάμων ἄοκνος, μεγάλαν προσορῶσα δόμοισι βλάβαν νέων ἀϊσσουσαν γάμων, τὰ μὲν αὐτὰ προσέβαλε· τὰ δ' ἀπ' ἀλλόθρου γνώμας μολόντ' ὀλεθρίαισι συναλλαγαῖς ἦ που ὀλοὰ στένει

He translates : "Of such things this hapless lady had no foreboding ; but she saw a great mischief swiftly coming on her home from the new marriage. Her own hand applied the remedy ; but for the issues of a stranger's counsel, given at a fatal meeting, —for these, I ween, she makes despairing lament, etc."

To get this sense Jebb has to accept four serious changes of the text. And yet the very words that are shown by the words in the corresponding strophe to be undoubtedly corrupt he passes by with the remark : "*στένει* is metrically suspicious ; the corresponding word in the antistrophe is *νύμφαν* 857." And must we not in the first place correct the words that we know are, on metrical grounds, undoubtedly corrupt ? Does it not show that their sense may fundamentally change our view of the whole sentence and render other conjectures unnecessary ?

In line 376 Deianeira talks of Iole as : *τίν' εἰσδέδεγμαι πημονὴν ὑπόστεγον λαθραῖον* ;

In v. 893 sqq. the chorus says :

ἔτεκεν ἔτεκε δὴ μεγάλαν
ἁ νέορτος ἅδε, νύμφα
δόμοις τοῖσδ' Ἐρινύν.

In v. 857 Iole is called *θοὰν νύμφον* and in 1139 she is referred to as *τοὺς ἔνδον γάμους*.

In the light of these passages I hold that the only corruption in our passage is to be sought in *ὀλοὰ στένει* as shown by the metre of the corresponding verse in the antistrophe. For *ὀλοὰστένει* i.e. ΟΛΟΑΣΤΕΝΕΙ I would propose *ὀλοᾶς τείνει* i.e. ΟΛΟΑΣΤΕΙΝΕΙ. *ὀλοᾶς* goes with *γνώμας*.

The thought of the chorus is that Deianeira sees the new woman Iole fall upon her home but she does not directly attack her. She follows a circuitous way. She tries to win Herakles' love back by following the advice given by Nessos the Centaur. This advice the chorus deems to be harmful.

The sentence runs thus :

ὧν ἅδ' ἁ τλάμων ἄοκνον μεγάλαν
προσορῶσα δόμοισι βλάβαν νέων
ἀϊσσόντων γάμων, τὰ μὲν οὔτι προσέβαλε·
τὰ δ' ἐπ' ἀλλόθρου
γνώμας μολόντ' ὀλεθρίαισι συναλλαγαῖς
ἦ που ὀλοᾶς τείνει, κτλ.

For the construction of ὧν I may refer to vv. 1208 *sq.*: οὐ δῆτ' ἔγωγ', ἀλλ' ὧν ἔχω παιώνιον καὶ μοῦνον ἰατῆρα τῶν ἐμῶν κακῶν, and Ant. v. 404: ὃν σὺ τὸν νεκρὸν ἀπεῖπας.

We may note the oblique reference to Iole ἄοκνον μεγάλαν βλάβαν νέων ἀϊσσόντων γάμων. She is not specifically referred to, as we have noted in other passages. Hence we have the indefinite τὰ μέν.

In the Ajax, 405 sq., we have another instance of this use:

εἰ τὰ μὲν φθίνει, φίλοι τοῖσδ' ὁμοῦ πέλας.

So the MSS. Jebb reads: εἰ τὰ μὲν φθίνει, τοιοῖσδ' ὁμοῦ πέλας suspecting πέλας for which he would read βοτοῖς.

In Uncials, I think, the text was:

ΦΙΛΟΙΤΟΙΣΔΟΜΟΥΠΕΛΑΣ—*i.e.*, φίλοι τ' ὄϊς δόμου πέλας.

I take ὄϊς to be nominative plural, contracted form, with diaeresis of the diphthong. In Homer we find ὄϊς the acc. plural. This gives good sense, and complies with the metre.

The translation runs: "This hapless lady seeing the fearless and great bane of the new marriage rushing upon her house in no wise attacked it, but made her plans on the mischievous interchange of thought with a stranger, a harmful thought I ween."

In the antistrophe, 853 sqq.

κέχυται νόσος ὦ πόποι, οἷον ἀναρσίων
οὔπω ἀγακλειτὸν Ἡρακλέους ἀπέμολε
πάθος οἰκτίσαι.

ἀπέμολε has the same meaning as ἀπέβη, resulted. Herakles was always victorious over his enemies. His suffering at their hands never resulted in his having to be pitied, as now with the robe which he received from no enemy but from his wife. There may be even some significance in inserting his name here Ἡρακλέους after ἀγακλειτόν.

Ibid. 1018 sqq.

Πρ. ὦ παῖ τοῦδ' ἀνδρός, τοὔργον τόδε μεῖζον ἀνήκει
ἢ κατ' ἐμὰν ῥώμαν, σὺ δὲ σύλλαβε σοί τε γὰρ ὄμμα
ἔμπλεον ἢ δι' ἐμοῦ σῴζειν. Υλ ψαύω μὲν ἔγωγε, κτλ.

Meineke says of this corrupt passage: "Mirifice torserunt criticorum ingenia." His own attempt at emendation is most radical in its changes: σὺ δὲ σύλλαβέ μοι· τὸ γὰρ ὁρμᾷ ἐς πλέον ἢ δίχα σοῦ σωκεῖν. Dindorf suspects a lacuna. Jebb accepts ἐς πλέον and changes σοί τε γὰρ ὄμμα into σοὶ γὰρ ἑτοίμα.

I take an entirely different view of the sentence. I hold that ὄμμα ἔμπλεον ἢ δι' ἐμοῦ σῴζειν is sound. The τε after σοι shows that the corruption must be sought there. The only change that we have to introduce is to turn the tau of τε into a gamma and divide the words correctly and punctuate properly. In Uncials the original text was ΣΥΛΛΑΒΕΣΟΙΓΕ—*i.e.*, σύλλαβε σ' οἶγε γαρ κτλ. We have to punctuate after ἔμπλεον as ἢ δι' ἐμοῦ σῴζειν is another sentence of the πρέσβυς which is left unfinished by the quick interruption of Hullos.

These lines therefore run:

> ὦ παῖ τοῦδ' ἀνδρός, τοὔργον τόδε μεῖζον ἀνήκει
> ἢ κατ' ἐμὰν ῥώμαν. σὺ δὲ σύλλαβέ σ'· οἶγε γὰρ ὄμμα
> ἔμπλεον. ἢ δι' ἐμοῦ σῴζειν . . . Υλ. ψαύω μὲν ἔγωγε.

Translate: "Collect thyself. Open thine eye full wide. Or through me to save . . . Hyllus: I am helping."

ἢ δι' ἐμοῦ σῴζειν. The interrupted thought might have been: Must I alone assist him?

For the ἢ I may refer to von Wilamowitz-Moellendorff's note on Euripides Herakles 1084, where he inserts it <ἢ> τάχα φόνον ἕτερον ἐπὶ φόνῳ βαλὼν | ἀναβακχεύσει Καδμείων πόλιν.

On p. 437 of his edition he says: "Das was eintreten muss, wenn sie dem befehle nicht folgen, wird durch einen Satz mit ἢ wie 1055 angeschlossen: ohne diese Verbindung würde die Verkehrtheit entsteken, dass Herakles trotz ihrer Flucht sie doch morden würde."

In our passage it seems that Hyllus showed signs of fainting at the sight of his father's agony, and the old man exhorted him to wake up. Naturally we have no indication how this part was acted. What lends force to my view of the passage is the last broken sentence of the old man, which was interrupted by Hyllus.

The simple verb οἴγω is found in Euripides, Aischulos, Homer, Hesiod, Pindar, etc.

For the σε = σεαυτόν we may compare Brugmann-Thumb, Griechische Grammatik (1913), p. 480: In der ion. und der att. Prosa waren die einfachen Personalpronomina (wie z. B. in K. 378 ἐγὼν ἐμὲ λύσομαι oder Eurip. Andr. ἐκδώσω μέ σοι) als Reflexiva schon verdrängt, und nur die formelhafte Wendung att. δοκῶ μοι, ἐμοὶ δοκῶ, herod. ἐγώ μοι δοκέω hielt das Alte fest (im Att. daneben auch ἐμαυτῷ δοκῶ." Compare Kühner-Gerth, Ausführliche Grammatik der Griechischen Sprache II. 1

§ 454 Anmerk. 8, p. 559. For further examples in Sophokles I may note: El. 363 and 461; Ant. 736.

For the phrase σύλλαβέ σ' compare von Wilamowitz's excellent note on Eur. Herakles 626 σύλλογον ψυχῆς λαβέ, p. 350 of his commentary.

In several places we have noted that a fruitful source of error in our MSS. is the wrong division of words by copyists. I may add two more examples, one from Euripides and one from Aischulos.

Eur. Herakles, 118 sqq.

μὴ προσκάμητε πόδα βαρύ τε
κῶλον ὥστε πρὸς πετραῖον
λέπας ζυγηφόρον πῶλον
ἀνέντες ὡς βάρος φέρον
τροχηλάτοιο πώλου.

For the corrupt φέρον I restore περ ὂν taking it as the accusative or nominative absolute. For the nominative absolute compare the newly-discovered fragment of Sophokles' Eurypylus, vv. 66-69.

The passage in Aischulos is Eumenides, 267-8:

καὶ ζῶντά σ' ἰσχνάνασ' ἀπάξομαι κάτω
ἀντιποίνους τείνης μητροφόνας δύας

For this corrupt passage von Wilamowitz, in his monumental edition of Aischulos, reads:

<ἵν'> ἀντιποίνους τίνῃς μητροφόντας δύας accepting the emendations of Abresch <ἵν'> and Pauw μητροφόντας. I hold that the corruption is much simpler. For τείνης I would restore πείνῃ 'ς. π and τ are easily confused and the 'ς was attached to τείνη becoming τείνης. Thus the last line runs:

ἀντιποίνους πείνῃ 'ς μητροφόνας δύας.

NOTES ON IRVING FISHER'S THEORY OF GOLD.

By Alexander Aiken.

(*Printed in "South African Accountant," December, 1917.*)

A PLEA FOR THE CLASSICS IN WOMEN'S EDUCATION.

By Miss K. M. Earle.

(*Not printed.*)

A PRELIMINARY NOTE ON DWARFS APPEARING IN GLUYAS EARLY (WHEAT) HYBRIDS.

By Prof. J. H. Neethling, M.Sc.

(With six text figures.)

My reason for this heading is due to two facts: (1) Owing to the limited time at my disposal, I was unable to treat the matter as fully as I wished, and (2) as the investigation in this matter is not yet completed, it may be unwise to treat it as finally settled.

In December, 1912, 149 plant selections were made on the farm of Mr. H. Theunissen, Jun., Langeberg, from the heterogeneous progeny passing under the name of Union wheat. According to R. W. Thornton,* the hybrid must have been made, probably by Dr. Nobbs, about 1906 or 1907, between Gluyas Early and Darling.

In 1913, 12 kernels of each of these selections were planted, each being marked U.1, U.2 etc., to U.149.

In the case of U.37, U.40, and U.45, there appeared respectively four, one, and three dwarfs, *i.e.*, out of 36 plants, eight were dwarfs. These plants were late, and hardly matured any seed.

In the case of U.37, 11 kernels were obtained, which were planted in 1914, all of these giving rise to dwarfs similar to the parents. Seed could hardly be said to have been produced, and no further account was kept of dwarfs in these selections, as better material was on hand. In brief, it may be stated that both parents are normal, and in the ordinary run of events never produce dwarfs when produced from normal seed. This fact was noted both from selected strains and from large fields grown.

In 1913 hybrids were produced between Rieti and Gluyas Early. As no selections of these varieties were on hand at that time, the Rieti mother parent was marked 36*a*, and the paternal Gluyas Early parent 41A, hence the hybrid was marked 36*a* × 41A.

For the characters under discussion a summary may be set down as in Table I.

Table I.

No.	Name.	Height of Plant in c.m.	Length of Ears in c.m.	Weight of Grain per Plant in gm.
(*a*) 36	Rieti	153	15	10.07
(*b*) 41-2	Gluyas Early ...	143	8.5	15.00
(*c*) 37*b*	Florence	136	8.5	13.3
Mean for 36a × 41A progeny—				
(*d*)	Total	149.170	11.524	15.943
(*e*)	Dwarf (in progeny)..	148.095	11.012	16.191
(*f*)	Normal...	149.781	11.859	15.781
Mean for 57b × 41a—				
(*g*)	Total	135.463	9.878	13.854
(*h*)	Dwarf (in progeny)..	137.182	10.045	13.0
(*i*)	Normal...	133.474	9.684	14.843

* *C.G.H. Agr. Journ.* (1910), 15-18.

In general the characters under discussion for the Rieti are reflected in the dimensions given; the same may be said for the Gluyas Early. (See Table I, *a* and *b*.)

All the above-mentioned parent strains give rise only to normal plants, if hybridisation does not intervene.

Dwarfs appeared in the second filial (F.2) generation. Few of these dwarfs mature any seed, and as the research is carried out with a view to producing economical wheat varieties, these had to be discarded. It would perhaps be interesting to establish whether this appearance of dwarfs is not due solely to the effect of Gluyas Early when used as the paternal parent, the more so as Rieti, the other parent in question, does

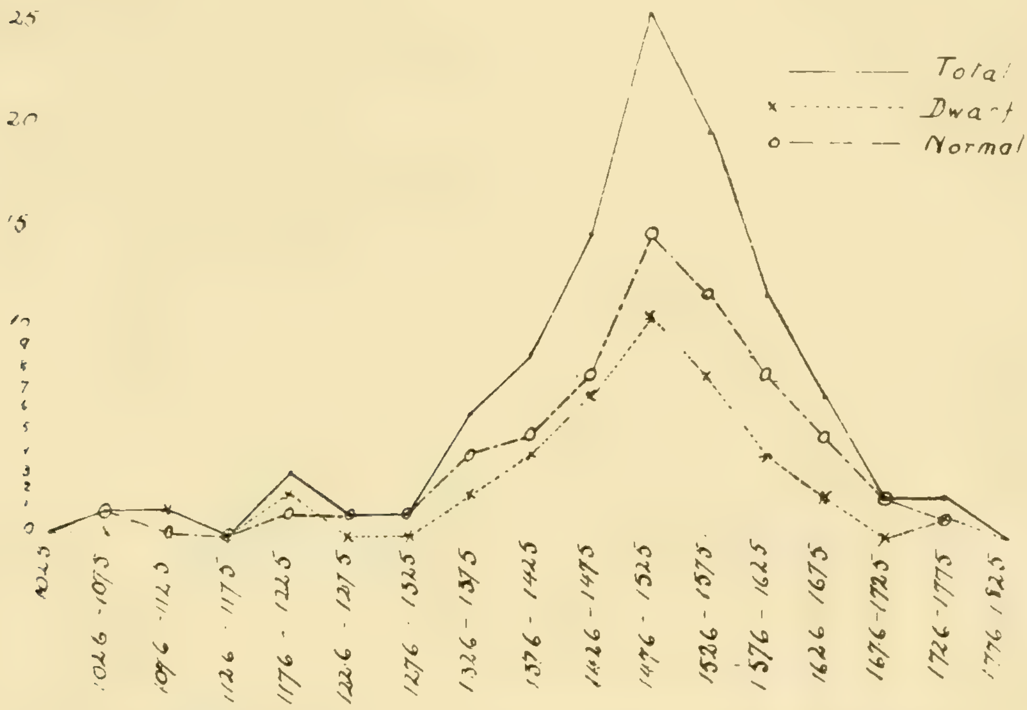


Fig. 1.—Frequency Curve for Height of Plant (cm.). 36*a* × 41.4.

not give rise to any dwarfs in its progeny, except when hybridised with Gluyas Early or perhaps a similar parent.

For this purpose it may be well to refer to reciprocal hybrids between Gluyas Early and Rieti, in which the F.2 progeny gave the following results:—

36 × 41-2 out of 15 plants 3 dwarfs

41-2 × 36* out of 16 plants 5 dwarfs.

i.e., out of 31 plants eight were dwarfs, immediately showing that dwarfness is a true recessive, and that this recessive appears no matter whether Gluyas Early be the maternal or the paternal parent.

* 36 = Rieti. This number 36 is a selection, therefore may be regarded as a pure line; thus both parents used in this case are pure lines, and future generations have already shown that they breed true to type.

For the further discussion 106 selections from the F.2 generation of 36*a* × 41A (Rieti × Gluyas Early) have been chosen.

Out of this 106, 42 gave dwarf forms in their progeny, *i.e.*, on the F.3 generation from apparently normal parents.

The total numbers of individuals from these 42 selections = 4,124, out of which the number of dwarfs = 948—*i.e.*, for true recessive theoretically there would be 4 : 1, *i.e.*, 4,124 : 1,031; giving thus a theoretical number of recessives of 1,031 as compared to the actual count of 948, in which the theoretical with the actual number compares as 25 per cent. : 22.99 per cent., a close enough relation to establish the fact that dwarfness is a

Fig. 2.—Frequency Curve for Length of Ear (cm.). 36*a* × 41*A*.

true recessive characteristic. It may be noted that even this actual number of dwarfs counted shows a less number than actually grew, as, in the cultivation of these rows, the unskilled labour used may have been responsible for removing some of the dwarfs, as these in the earlier stages of growth are very grass-like, and consequently may be removed.

There are a number of instances where the actual number for the recessive very nearly approaches the theoretical number, *e.g.*, in selections 1, 30, 46, 66, etc., there are respectively 24 : 77; 46 : 131; 15 : 43; 24 : 70, dwarf : tall.

In another series of hybrid progeny Florence × Gluyas Early *i.e.*, 57*b* × 41*a* (for 57*b* see Table I, *c*)—from 41 selections of

apparently normal plants of the F.2 generation, 22 yield dwarf progeny. Out of a total of this population of 2,149 plants, 476 were dwarfs; theoretically 537·(25) dwarfs should have appeared; *i.e.*, instead of 25 per cent. only 22.15 per cent. were

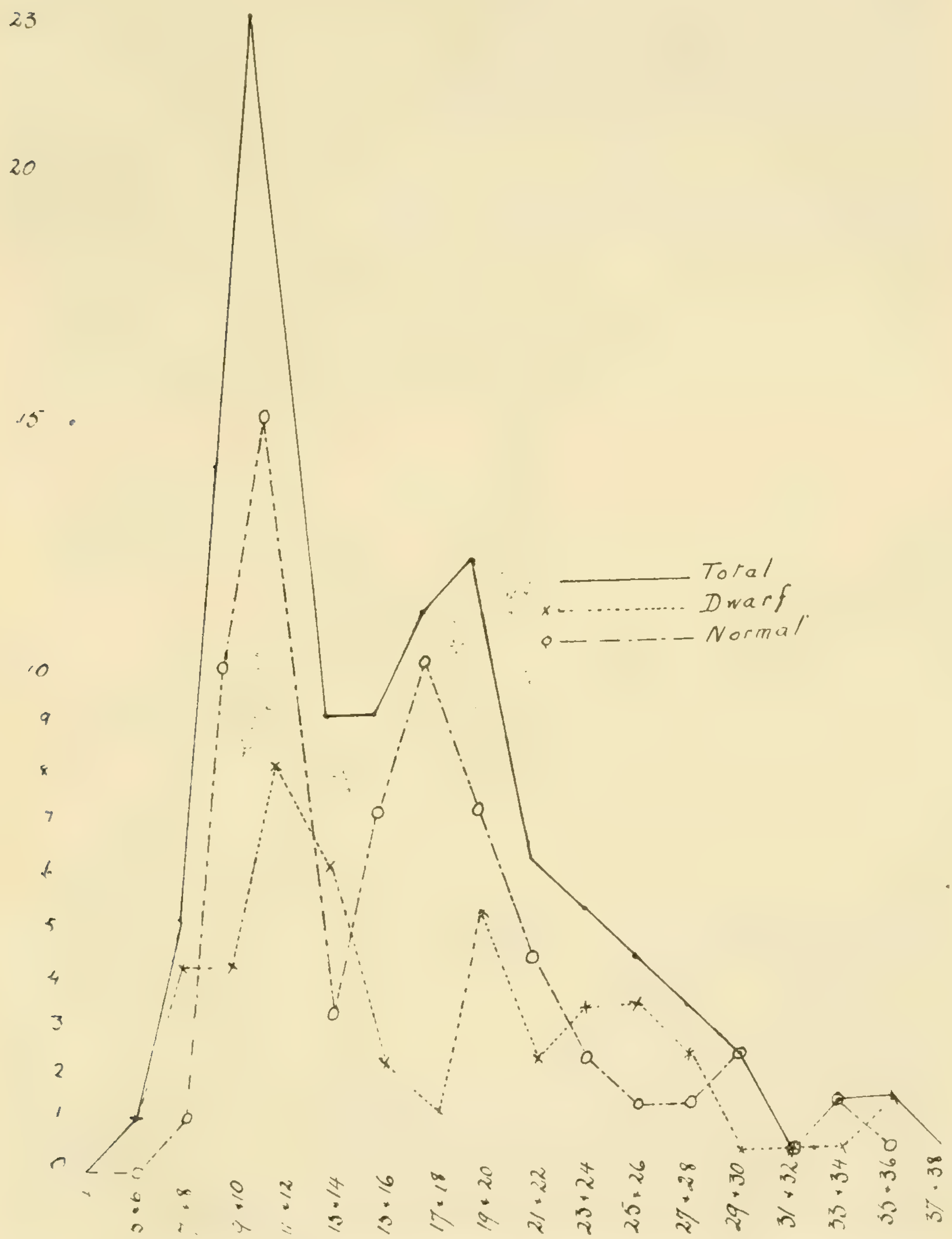


Fig. 3.—Frequency Curve for Weight of Grain (grm.). 36a × 41.1.

dwarfs. The same reason as above-mentioned may have been the cause for a decrease of the dwarfs before counting.

These cases cited may be taken as fairly conclusive evidence of the true recessiveness of the dwarf character as far as these wheats are concerned.

For the present it will perhaps be best to limit the discussion to these two series of hybrid progeny.

Alone from the standpoint of the economical breeding for improved varieties of wheats, it is plain that these dwarfs furnish an obstacle which causes greater labour, as none of the dwarfs thus far have shown to have any enonomical value, and especially as thus far there is no criterion by which it can be established beforehand whether an apparently normal individual from such a progeny will give rise to dwarf forms; the only method of ascertaining this fact lies in the propagation of such individuals for another generation. When, however, as it is thought, one of our best parent strains, *e.g.* Gluyas Early, is frequently producing this uneconomical factor in its progeny, it may be neces-

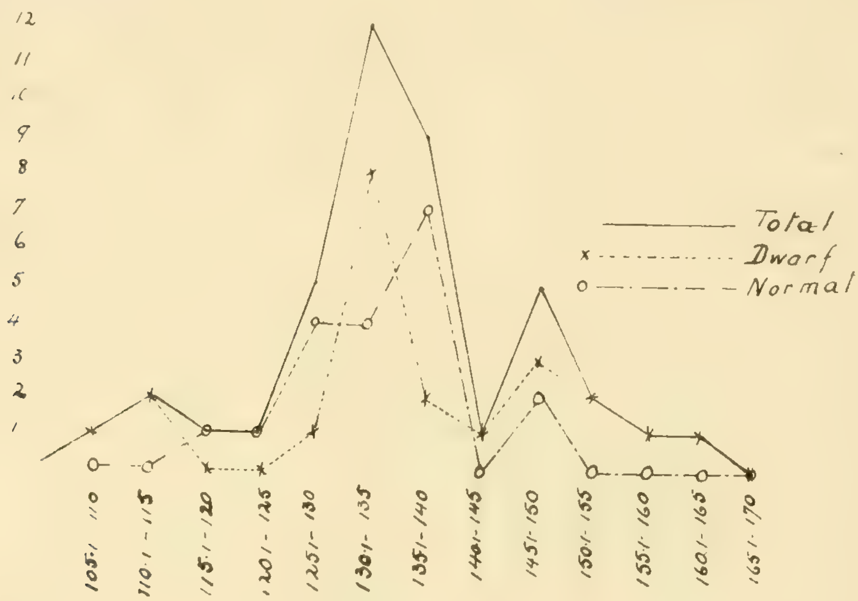


Fig. 4.—Frequency Curve for Height of Plant (cm.). 57*b* × 41*a*.

sary to enquire further into the matter to ascertain whether no solution is possible.

Such an investigation may also give rise to other factors of importance.

Be it here briefly stated that natural hybrids are produced between different strains of wheat, and perhaps to a greater extent than is generally believed to be the case. In one instance, for example, the knowledge of dwarfness has been of assistance, in so far as a selection was made from a variety of wheat which evidently was nothing else but an F.1 hybrid; and as was apparent from the progeny, the paternal parent could be established. In so far, then, it may be of use.

However, as in the case of the 106 selections of the 36*a* × 41A, 42 gave rise to dwarfs, and in the case of 41 selections of 57*b* × 41*a*, 22 gave rise to dwarfs; so that, unless further selection is practised, these, even though having exceedingly desirable qualities, cannot be propagated owing to this, from an economical

point of view, unfortunate quality. These selections were in some respects even very fortunate, as theoretically two-thirds of the total should have given rise to dwarf progeny. The reason for this fortunate result remains difficult to explain, and many factors may have a bearing on the case.

The populations taken as examples, though embracing only 106 individuals in the case of 36*a* × 41A, and 41 in the case of 57*b* × 41*a*, are nevertheless representative for illustrating some phases which may be of interest, and may perhaps throw some light on this matter.

Quantitative characteristics, unlike certain qualitative characteristics, still remain unsolved when considered from a definite Mendelian point of view, but here may be an instance, even though the object be practical breeding, in which the segregation of such a quantitative characteristic may perhaps be more nearly solved, the more so as at least one recessive is evident. Knowing that dwarfness is recessive, will it be correct to assume that

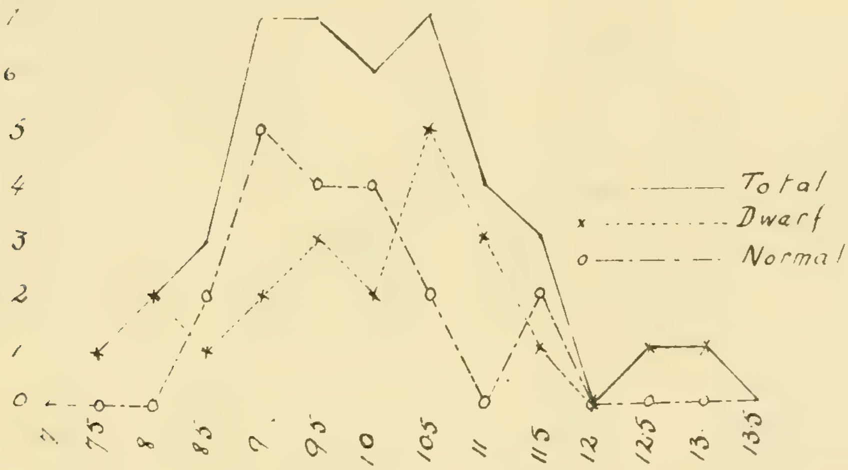


Fig. 5.—Frequency Curve for Ear Length (cm.). 57*b* × 41*a*.

normal height is dominant, and that height and dwarfness are an allelomorph?

This need not be, for the two parent forms already differ in their normal height, and it is not incorrect to predict that strains may be established breeding true to type as far as height is concerned, such strains varying probably from a height greater than that of the tallest parent to a height much less than that of the shortest parent; therefore height and dwarfness cannot be taken as one allelomorphic pair of characters in the present case.

It is not even necessary that in the case of 36*a* × 41A the characteristic height may embody the same number of allelomorphic pairs of characters as in the case of 57*b* × 41*a*, nor need this be expected. If, however, there is an indication that it is possible to divide these quantitative characteristics into various classes, each class being either homogeneous or heterogeneous in

capacity, and if it is found that in the segregation some or all of the classes yield pure recessives, then naturally it may be concluded that those classes giving this recessive dwarfness are allelomorphs; *i.e.,* the pure normal height of such a class and dwarfness forms an allelomorphic pair, and these, together with such classes which may not give rise to dwarfness, make up this compound quantitative characteristic.

Naturally, then, a population may contain various allelomorphs, all combining to make up one characteristic such as height, the allelomorphs being simply classes ranging between various dimensions, so that with the natural variation in each class it may be found difficult to distinguish whether an individual belongs to the allelomorphic class having either a greater or a less dimension, the more so as the possibility exists that each class

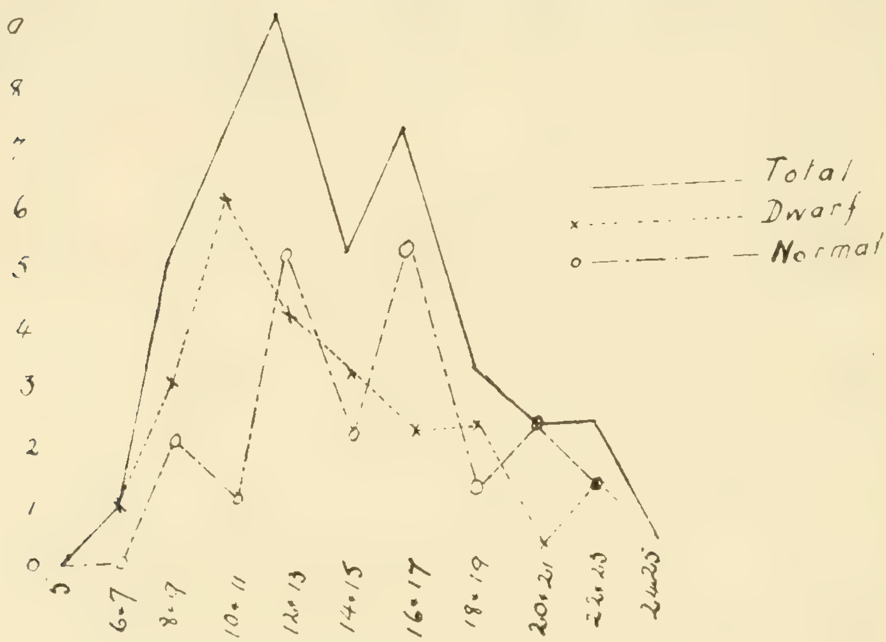


Fig. 6.—Frequency Curve for Weight of Grain (grm.). 57*b* × 41*a*.

representing an allelomorph need not have the same limits within which it varies, and the natural variation in such classes may cause individuals to appear as belonging to a higher or lower class in height.

From Table I it is apparent that the mean height ranges between the normal heights of the parents in the 36*a* × 41A progeny; the same holds true except in regard to the progeny of parents yielding all-normal progeny.

In comparing curves I and IV, giving a comparison between the frequencies of the height of parents (1), total, *i.e.*, parents yielding dwarf progeny and normal progeny, (2) yielding dwarf progeny, and (3) yielding normal progeny, it will be noticed that the curves do not represent a population which breeds true to the characteristic height, but gives an indication that for the character height there are various populations to be considered. Moreover,

the parents yielding the recessive dwarfness are represented in some or all classes, which may go to show that this mixed population for height may be subdivided into various classes, such classes embracing individuals which may breed true to the characteristic height. The normal class height and the dwarf form may then be taken as an allelomorph. This may be the reason for the mean height (Table I, *h*) for parents producing dwarfs being greater than either the mean for those for the total or for the normal (Table I, *g* and *i*) as is readily to be seen in that all parents over 150.1 cm. gave rise to dwarf progeny.

Comparing the frequency curves II and V for ear length instead of for height of plant as above-mentioned, the same indications are produced, and this is also the case where weight of grain forms the basis as in curves III and VI.

In the present discussion three quantitative characteristics are considered, and indications are found to show that quantitative characteristics may become subdivided into what may perhaps be called class-allelomorphs, each such a class-allelomorph acting similar to allelomorphs in which the pairs of characters have reference to qualitative characteristics.

The reason why the present hybrid material may be the criterion for more definitely translating the characteristic such as height into Mendelian terms is simply because the recessive dwarfness is a distinguishable characteristic, though for the present it is difficult to give accurate dimensions of the degree of dwarfness, as dwarf individuals rarely mature, in most cases the ears remaining enclosed in the apical leaf sheath.

INDUSTRIAL DEVELOPMENT.

By Kenneth Austin, M.Am.I.M.E.

(Not printed.)

THE ASCENT OF SAP IN PLANTS.

By Prof. Horace Athelstan Wager, A.R.C.S.

(Not printed.)

VARIATION IN *AGERATUM CONYZOIDES* (FAMILY COMPOSITÆ.)

By Stephen Gottheil Rich, M.A., B.Sc.

(Not printed.)

SOME SENSE DEFECTS CONSIDERED PSYCHOLOGICALLY.

By the Rev. Frederick Charles Kolbe, B.A., D.D.

With two text figures.

The old dictum that exceptions prove the rule is never better exemplified than in the light which pathology throws on normal processes. Unfortunately for psychology the victims of the pathological condition are often least able to tell their experience. To give such testimony usefully requires not only scientific observation and a knowledge of psychological demands, but also freedom from bias in self-inspection. Many, otherwise competent, are fanciful or untrustworthy in describing their own symptoms.

As in this paper I am utilising my own experience, I ought to prove my possession of this threefold qualification.

When I went to London a good many years ago to be treated by an aurist, I was recommended to choose Dr. Woakes, of Harley Street, who was described to me as brusque and laconic, a sort of Abernethy. I put together an account of all my observations and experiments on myself, and handed the paper to him at our first interview. "It may save some words to read this, doctor," I said. He took it with a cynical smile, as who should say, "I have seen this sort of thing before." But the smile died off his face as he read, and at the end of it he looked hard at me, and read it all over again carefully. Then, abruptly: "May I keep this paper?" "Certainly, doctor. I wrote it for you." "It is the best statement of a case by a layman that I have ever seen. I don't need to ask you a single question. Come and sit down here." Then he began working on me.

I write this, not for any self-satisfaction in the telling, but as an indication to strangers that my testimony is likely to have two of the above-mentioned qualities, namely, accuracy of scientific observation and freedom from fanciful bias. The third, namely, the psychological, will (I hope) reveal itself in the course of my paper.

I have the misfortune to be a first-hand authority on defects of both hearing and sight. I shall begin with the former.

The defect I am to discuss is due to a gradual collapse of the Eustachian tube, the result probably of a local flabbiness of muscle, which also relaxes the tension of the drum. Any stretching of these muscles would be a temporary remedy. After a yawn, I used to hear for a moment perfectly well. I used also to be able, holding mouth and nose, to force air into the Eustachian tube, with the same result.

The consequence of this condition is that all except very soft sounds are perceived, but with a blurred outline. It is like

a normal person listening to a murmur of conversation just beyond his range, or like a man in a far corner trying to hear a speaker whose voice does not fill the hall. In the former case, everybody knows how without attention nothing is heard; hard listening will give a word here and there; if the topic is known, the drift can be followed; if the person's own name is mentioned, he is at once aroused even if he had not been listening. In other words, the difference between hearing and not hearing depends on the attention, the knowledge, the skill in guessing, the familiarity which the listener can bring to bear on the sounds. He will also be helped if he can see the expressions and gestures of the interlocutors. In the other case, the want of audibility is usually the speaker's fault. Actors can make a large audience hear a stage-whisper. It is not shouting, but clear articulation that is wanted. In this, as in many other respects, our King George gives good example to his people. When he was here as Duke of Cornwall and York, and we made him Chancellor of the University, I had an opportunity of judging. Sir T. Muir, then Vice-Chancellor, is an incisive speaker, and I heard about three-quarters of his words, and was able to infer all the rest; but when the Duke spoke, there was no need of inference; every syllable was clear-cut, and I could have heard him even at a much greater distance. But the worst fault speakers have—and only a deaf man knows how common and how annoying it is—is putting emphasis on the wrong place. It is like a journalist scoring unimportant phrases for printing in large type. To this is added a still more deplorable habit, equally common, of trailing off the voice and sinking it at the end of a sentence, as if there was not energy enough to go round. Of many a speech I have to listen to, this is all that reaches me:—"Now, sir, . . . not that . . . . But, still . . . . I don't say . . . . And here is one point I wish to draw special attention to—— Mumble, mumble, mumble . . ." If the *vis viva* of the voice were put into the really important words, and the energy sustained at the close of the sentence, it would be a great boon to those hard of hearing.

The deaf man has to make rapid inferences from expectation and familiarity. Everybody, I believe, "hears" largely by these means—as can be seen from the difficulty a normal person has in catching proper names over the telephone—as soon as inference is impossible, he hears worse. The intellect plays a much larger part in sensation than the psychological text-books seem to admit. It is this fact which makes the hearing of a deaf man such a puzzle to most people. I had a friend of very varied interests, who was quite acrobatic in his changes of subject. He used to say to me, "I can't make you out. You seem to hear all right for a while, then suddenly you become hopeless"—the fact being that he had made one of his jumps without warning me, and I was bewildered by trying to fit a tirade on the wool-question into a theory of Egyptian Art. Once, travelling

through the Berg River Valley, a friend of mine waved his hand towards the scenery and said something of which all I heard sounded like *airtoo*. With this I had two grounds of inference: (1) he must mean the Drakenstein Mountains, because that was all he could see from where he was; and (2) I knew him to be an incorrigible punster. It took me a full minute to realise that he had gaily said, "These are some of the 'ills that flesh is heir to." To this day, I believe, my friend thinks I was very dense to take so long to see his pun. He does not know what a conundrum he set me. A still better example shows how a few articulate sounds with their accompanying murmur can be "heard" when subsequent light is thrown on them. As we were walking in the street, a friend said something to me, of which I caught three syllables, with a vague consciousness of the rest. I tried to fit this into English, and failed. Then suddenly it dawned on me that some people were passing at the time, and my companion might have wanted them not to understand. In that case, he would have spoken Italian. I fitted my raw material together in that language, and after about a hundred yards I answered him. "You took a jolly long time to reply," he said. "I have only just heard it," I rejoined.

I add a good example of the value of attention and expectation. There is a big bell within a few yards of my room: its voice is easily heard all over Capetown, but when my door and window are shut I do not hear it at all—unless I prepare for it. I know the time when it is going to ring. I then attune my ear to the musical note it sounds (E flat). Then, if I have hit both time and note rightly, I not only hear the bell, but hear it quite loudly.

Moreover, I think we are helped more than we know by the vibrations in the bones of the head. If I close both my ears as tightly as I can, I still hear music almost as well as when my ears are open.

Once more, it is frequently thought that all sound waves travel with a perfectly spherical wave-front. This is true only of stationary sound-centres. When a sound is thrown forward, as in the case of the voice, the side waves are comparatively very weak. No matter how well I am hearing, the moment the speaker turns aside I am lost. I may therefore venture to give some hints equally useful to a public speaker who wants the outside fringe to hear him, and to the private speaker who is dealing with a deaf person:—(1) Throw the voice where you want it to go; (2) do not shout, but articulate; (3) emphasise the really important words, not the links; (4) make sure the topic of each paragraph is known; (5) sustain the voice fully to the end of each sentence, and if you use a falling cadence, let it be a definite one and not a mere trailing into weakness.

The second defect, that of sight, is much more complex. It is near sight, combined with slow sight, and two-fold retinal hemorrhage supervening.

The phenomenon of slow sight is, I presume, due to some sluggishness in nerve-current, and not to the state of the nerve-ending. I have known people complain of it whose sight was quite normal otherwise. It obviously provides a question of importance for psychology, but I do not see it treated in the text-books. Personally, it has been a source of much inconvenience to me. I have, for example, when walking fast, met a lady of my acquaintance. I have seen her bow, and seen the expression of annoyance at my lack of response—but all after I had passed.

Now there is a "test" one reads of for estimating power of observation: it consists of making people pass a shop window, previously unseen, and of recording the number of objects they can assert they have seen. In my case the verdict would undoubtedly be "below par." But as through life I have habitually observed Nature more effectively than most of my companions, I venture to think this "test" quite fallacious.

There are two qualities in my vision which seem to be inconsistent with what I have said, viz., sensitiveness to movement and to colour. I suppose our sense-organization admits of inconsistencies as much as our mind does. No one is quite logical throughout.

As to movement, there used to be in the north window of our cathedral a hole which sent an image of the sun on to our sanctuary. The image was an ellipse of about two square feet in area. Whenever I looked at this image, as it shone on the white steps of the sanctuary, I always got a first impression that it was *flowing* down the steps. When I looked hard at it, the movement could no longer be seen; though it was easily measurable at intervals of three or four seconds. The impression quite startled me the first time, but it was always repeated, and I am quite sure of my statement. Again, going once with the Mountain Club to the Tulbagh Waterfall, I was walking with a person of normal sight, an oculist, by the way, and suddenly at a bend I saw a white moving streak. "The Fall," I cried. "Nonsense," said he, "it is the white trunk of a tree." "But I see it moving," I persisted. And we walked quite a hundred yards before he could see the movement. [N.B.—I must have been helped to confidence in contradicting him by the knowledge that no tree with such a white trunk could possibly be growing in that locality; but the movement I distinctly saw, and that far beyond my range of vision of form.] This was very useful to me once in science. I was collecting insects in South Rhodesia, and the train made a long stop at a place where, as far as the eye could reach, there was only one tree (an acacia) on the grass veld. I knew there would be something on that tree, and made for it. I examined leaves, twigs, branches and trunk, but in vain. After at least twenty minutes, I gave up in despair and turned away. But, knowing the wary habits of our wild life, I turned sharply back after going two or three steps. There was a minute, but unmistakable, movement. I

rushed back to the spot and found quite a large beetle, shaped much like a piece of the bark, and snuggling into the crevice to add to the illusion. Moreover, however he had done it, the rogue had further *camouflaged* himself by pasting little bits of bark on his back. Once I found him, it was easy to find other little "bits of bark" of the same shape, and I gathered in about a dozen of them—all because that one had not been able to refrain from shouting "Hurrah!" with his antennæ too soon.

Sensitiveness to colour has stood me in equally good stead. No one could believe what the blue of the *Aristea* on the Paarl mountain meant to me in my early childhood. A stranger walking with me once pointed about a hundred yards ahead to some flowers that struck him. "Homeria collina," I said. "But," said he, "I shouldn't have thought you could even see there was a flower there." "No more can I," I replied, "but I see a splash of colour, salmon pink, and no other flower of that colour grows here." Again, walking with a doctor once round the Kloof, with a clear sun declining in the west and a mist over the last buttress of the Table, I pointed suddenly and said, "How lovely the rainbow colours are when mingling with the vegetation." He looked carefully, and then turned to me: "There's nothing there: pure imagination: you had better mind or you will be getting hallucinations one of these days." Just then the sun shone out more clearly, and the rainbow finished all over the sky. I never saw a man more taken aback. Moreover, when I lift my arm in the sunlight, I can distinctly see the iridescence of the small fibres on the surface of my black coat, though I cannot see when my coat needs brushing or cleaning.

Now, these two points, and I suppose there are others, have to be taken into account before a psychologist dogmatises about "power of observation."

The defect of near-sight with me is a form of astigmatism, the results of which seem not to be commonly known. At least I find them in no book within my reach, and even medical men sometimes seem surprised when I talk of clear multiple vision with a single eye. Perhaps therefore it is worth describing.

The defect lies in the cornea (or front of the eye) rather than in the lens. The bulge of the cornea (which I can feel with my finger through the eyelid) causes a parallel ray to be refracted at very various angles on to the lens. Each little region comes to its own focus on the retina, and the result is between 50 and 100 images of a candle-flame (say) arranged in a circle, but so superposed as to lose all outline. This is why near-sighted people (as I discovered for myself very early in life) find their vision cleared by looking through a pin-hole in a card: it cuts off all except the few central images, and the true outline becomes perceptible. As years went on, and the bulge of the cornea increased, the images came to be set further and further apart, until one day, while experimenting with a small electric light, I happened to look at it with my spectacles off, and to

my amazement I saw what I have endeavoured to depict in Fig. 1.

This phenomenon developed until larger lights also separated their images. I once counted 64 clear distinct full moons in my right eye.

The next stage that supervened was hemorrhage of the retina owing to straining the eye: this was in the right eye, till then the better one. The immediate result was a dark ellipse in the very centre of the optical field, surrounded by a most lovely rainbow. This was "visible" even when the eye was shut. In due time the figure faded away, but I have never read with that eye since. I suppose a little clot of blood formed right over the yellow spot.

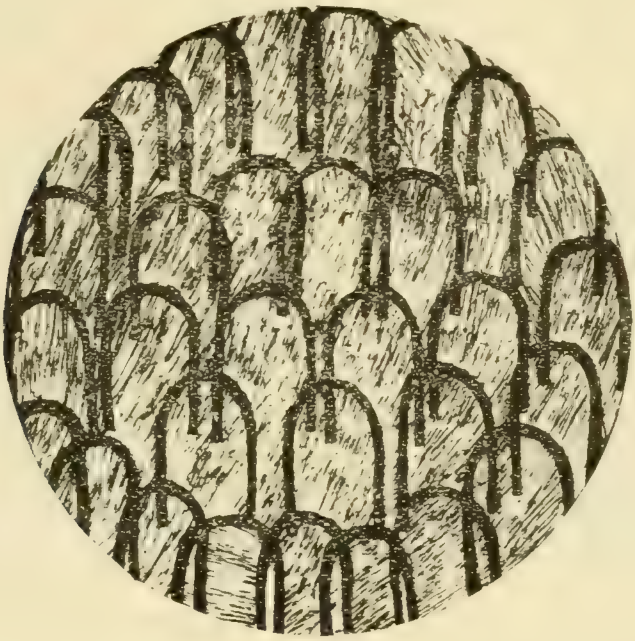


Fig. 1.

I thought I was lucky to keep my left eye safe anyhow; but one night I fell over an obstacle in our garden, and nearly had that eye pierced by a couple of seedling-stakes. Permanent black figures immediately appeared at the side, and I knew that in the instinctive effort to save itself the eye had suffered some lesion of the retina. A short while after there came a sudden gush of blood, and that eye was for a while quite blind.

I am aware that at the time there was published an account of the matter, denying the accident. What motive the person could have in contradicting what he knew to be my description of my own experience, I do not know. I cannot say he was ill-informed: I simply say his statement was untrue. And it becomes important in this connection to say so, because if both lesions had resulted from eye-strain, they would probably both have been central, whereas now I am able to describe the difference between a central and a lateral lesion.

Bleeding on the retina, of course, plays havoc with the delicate nerve-endings. The present appearance of a candle-flame at a distance of about 6 feet I have endeavoured to show in Fig. 2.

The right eye (on the reader's right), it will be noticed, has no central image: the left eye has. I need not say I watch that central image lovingly and anxiously: if it goes, I shall no longer be able to read.

It will be understood that for both eyes the whole circle is a blurr of mottled light with the indicated figures standing out more or less clearly. The right eye has one little clear image outside the circle: I cannot explain it, but it is always there.

I had a strange experience after the gush of blood in the left eye had settled down and left the eye clear again. Lying down one afternoon, and looking at the ceiling while the light from the window entered the eye obliquely, I distinctly saw what is quite familiar to me as a microscopic view of the red

Fig. 2.

corpuscles of blood. I cannot be mistaken: the shape of each corpuscle was quite clear, and (as scientists know) it is unique. I could repeat the experience at will until the blood had time to be quite re-absorbed. It is a curious variant of the experiment by which some people are able, with a proper adjustment of oblique light, to project into the darkness a highly magnified view of their own retinal blood-vessels. But I wonder whether anybody else has ever seen and recognized his own blood-corpuscles without their leaving the body.

The next point of psychological interest was that the two images, till then firmly co-ordinated, began to separate. It was as if the bodily system had a will of its own apart from consciousness. There was a long struggle between me and it. I had complete control over the muscles, and was able always to put the straying right image back again. I could even move it at will and attend to both images at once. I often, for fun, used to put one person's head on another person's shoulders to see the effect. I was able to compare tile or wall-paper pat-

terns to see if one figure would exactly fit its neighbour. They always did, with deadly monotony. But the body got the best of it. After an interval, in which I had relaxed my conscious efforts, I found that the images were firmly separated, and now I have quite lost control, and can do nothing to make the right image even approach the left. Moreover, my hands and feet refuse to obey the right image. If I shut my left eye and try to touch something on a table, I miss by about 4 or 5 inches. I once tried to walk with the left eye shut, and found myself colliding with lamp-posts. Anxious to preserve my reputation for sobriety, I do not repeat that experiment. But it is surely curious that two sets of muscles should have passed from a state of will-resisting co-ordination to a state of equally will-resisting dis-co-ordination, through a period of perfect separate will-control.

A further consequence has resulted. It is well known that our perception of colour is so "interpreted" by the mind, that artists have to unlearn the interpretation. Sunlight should be "seen" more yellow, shadows more purple, and candle-light more red. Now, that is what has happened to my right eye. Since the "mind" has made up its mind to ignore the right image, the two eyes give quite a different colouring. And I do not think it is a new defect, one of partial colour-blindness: such defects rarely, if ever, come nearer to the truth. The fact distinctly is that for my right eye sunlight is more yellow, shadows more purple, and candle-light is almost as red as Gherardo delle Notti ever painted it.

Yet one more optical effect may be noted. Looking once at a white object, surrounded by shadow, but itself in the light, my right eye being closed to block off its image, I found that on opening that eye the left image immediately *brightened.* This could not be from super-position of images, because that is impossible now to me; nor could it be from access of light from surroundings, for all was gloom around. However, to make quite sure, I put my hand before my right eye, and then found, to my amazement, that the mere opening of the right eye (though it saw nothing) reinforced the image of the left. Evidently the extra flow of energy was shared by sympathy. From this one can easily believe that it is not merely a poetic fancy that things look brighter when we are gay and gloomier when we are dull.

Last of all, my experience is that the muscles in the head which subserve attention are so sympathetically linked together that each contributes towards the action of the rest. Normal people have enough energy to be able to use their senses together. I cannot. If I read, I cannot hear. If I listen, I cannot look. A friend asked me to dinner twice: the first time he asked me to choose the wine, and I patriotically chose Witzenberg: the next time he chose for himself, and we had one of the choicest Rhine wines: unfortunately I did not notice the difference, and he thinks poorly of my taste. If he reads this paper he will know that I prefer my friends' conversation to the most epicurean

palate-tickler the world can tempt me with, and as I was listening to him I simply could not attend to his wine.

Further, it sometimes amuses my friends that when I am looking hard at anything I instinctively put my hand to my ear. It simply means that *all* attention-muscles with me have to be strained for the service of each of the senses. It enables me to hear better in the dark if I put my spectacles on, though there is nothing to see. This strange co-ordination of our attention-energies seems to me to be worth some psychological consideration.

I have put together these experiences in the hope of starting trains of thought, or at least of providing illustrations, for teachers of psychology.

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1916. †Crookes, George Joseph, The Cedars, Renishaw, per Private Bag, Durban.
1916. Cruden, Frank, Alicedale, C.P.
1903. †Cullen, William, M.I.M.M. (General Secretary, 1905-1908), Westwood, The Avenue, Upper Norwood, England.
1916. Currie, Richard, 112, Commissioner Street, Johannesburg.
1903. Currie, O. J., M.B., M.R.C.S., Claremont, Capetown.
1916. Curry, N. O., P.O. Box 2303, Johannesburg.

1905. Dale, Hubert, P.O. Box 632, Johannesburg.
1903. Dalrymple, *Hon.* W., P.O. Box 2927, Johannesburg.
1915. Dalton, John Patrick, M.A., D.Sc., Professor of Mathematics, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.
1913. Damant, E. L., P.O. Box 1176, Johannesburg.
1916. Danckwerts, Ernst, P.O. Box 486, Johannesburg.
1913. Daniel, John, Armley House, 30, Plein Street, Johannesburg.
1916. Davidson, D. M., P.O. Box 455, Germiston, Transvaal.
1917. Davidson, John, P.O. Box 1146, Johannesburg.
1918. Davies, David Ernest Lloyd, M.I.C.E., F.R.San.I., City Hall, Capetown.
1903. Davies, J. Hubert, M.I.E.E., M.I.Mech.E., A.M.I.C.E., P.O. Box 1386, Johannesburg.
1916. Davis, Carl Raymond, E.M., M.Am.I.M.E., P.O. Box 3, Brakpan, Transvaal.
1903. Davis, Frederick H., B.Sc., M.I.E.E., P.O. Box 1934, Johannesburg.
1916. Daymond, William Henry, P.O. Nigel, Transvaal.
1916. Deakin, James Alfred, Dunswart Iron and Steel Works, P.O. Box 290, Benoni, Transvaal.
1916. De Fenton, John, Ph.D., Seymour Memorial Library, P.O. Box 2561, Johannesburg.
1915. De Klerk, Arie, 486, Schoeman Street, Pretoria.
1915. De Kock, Gilles van de Wall, M.R.C.V.S., Veterinary Research Office, P.O. Box 593, Pretoria.
1914. De Kock, *Dr.* Servaas Meyer, P.O. Box 321, Bloemfontein.
1917. De Korte, William Edmond, M.B., M.R.C.S., L.R.C.P., Lloyd's Buildings, Burg Street, Capetown.
1913. Delbridge, William John, A.R.I.B.A., P.O. Box 120, Capetown.
1915. Delfos, Cornelis Fredrik, P.O. Box 24, Pretoria.
1904. Delmore, *Dr.* J. Schlesinger, P.O. Box 1455, Johannesburg.
1916. De Ropp, Stephen Edward, *Baron,* B.Sc., F.G.S., University College, Johannesburg.
1916. Des Clayes, Raymond, P.O. Box 155, Johannesburg.

Year of Election.

1915. De Villiers, C. G. S., M.A., 681, Pretorius Street, Arcadia, Pretoria.

1916. De Villiers, *Rt. Hon.* Charles Percy, *Baron*, Rustenburg, Stellenbosch.

1915. De Villiers, Louis Celliers, Ph.D., M.E., Lecturer in Geology and Mineralogy, Transvaal University College, Pretoria.

1915. †Dick, *Colonel* James, St. Thomas Road, Durban.

1916. Diethelm, Carl Robert, P.O. Box 3228, Johannesburg.

1917. Dijkman, Cornelis Derksen, M.A., Grey University College, Bloemfontein.

1916. Dinwoodie, James Herbert, F.C.S., 53, Cavendish Road, Yeoville, Johannesburg.

1917. DOBSON, *Lt.-Col.*, JOSEPH HENRY, D.S.O., M.Sc., M.Eng., M.I.Mech.E., M.I.E.E., A.M.I.C.E., P.O. Box 699, Johannesburg.

1916. Dodds, Herbert Henry, M.Sc., F.C.S., c/o Messrs. Kynoch, Ltd., Umbogintwini, Durban.

1909. Dodt, J. J., National Museum, Bloemfontein.

1917. Doering, F. Emanuel, M.D., D.D.S., P.O. Box 2165, Johannesburg.

1915. Doidge, Ethel Mary, M.A., D.Sc., F.L.S. (Vice-Pres. C), P.O. Box 1294, Pretoria.

1911. DORNAN, *Rev.* SAMUEL S., M.A., F.G.S., (Vice-Pres. E), P.O. Box 106, Bulawayo.

1908. Drège, Isaac Louis, P.O. Box 148, Port Elizabeth, C.P.

1917. Drennan, Charles Maxwell, M.A., Professor of English, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.

1914. Dreyer, P., Resident Magistrate's Office, Capetown.

1915. DREYER, THOMAS F., B.A., Ph.D., Grey University College, Bloemfontein.

1917. Dreyfus, Paul, P.O. Box 5836, Johannesburg.

1906. †Druce, P. M., M.A., The College, Potchefstroom, Transvaal.

1902. *Drury, Edward Guy Dru, M.D., B.S., D.P.H., Grahamstown, C.P.

1917. Dryden, Thomas Alexander Wemyss, Mines Department, Krugersdorp, Transvaal.

1915. Du Boulay, Alice Mary Houssemayne, Transvaal Education Department, Pretoria.

1917. Du Pasquier, Arthur Edmund, M.I.M.E., M.I.E.E., P.O. Box 3633, Johannesburg.

1917. Du Plessis, *Rev. Prof.* Johannes, B.A., B.D., Theological Seminary, Stellenbosch.

1917. Du Toit, Alexander Logie, B.A., D.Sc., F.G.S., P.O. Box 61, Capetown.

Year of Election.

1913. Du Toit, A. E., M.A., Professor of Mathematics, Transvaal University College, Pretoria.

1917. Du Toit, Andries Francois, P.O. Box 463, Capetown.

1917. Du Toit, Hendrik Lodewijk, Michville, *via* Honey Nest Kloof, C.P.

1917. Du Toit, Pieter Jacobus, B.A., Hilton College, Hilton Road, Natal.

1915. Du Toit, Pieter Johannes, Under-Secretary for Agriculture, Union Buildings, Pretoria.

1906. Duerden, James E., M.Sc., Ph.D., A.R.C.S., Professor of Zoology, Rhodes University College, Grahamstown, C.P.

1915. Dumat, Henry Aylmer, M.D., F.R.C.P.E., 7, Devonshire Place, Durban, Natal.

1910. Duncan, A., P.O. Box 1214, Johannesburg.

1904. Duncan, Patrick, C.M.G., M.L.A., Sauer's Buildings, Johannesburg.

1909. Dunkerton, Edward B., c/o Messrs. Lennon, Ltd., West Street, P.O. Box 266, Durban, Natal.

1917. Duthie, Augusta Vera, M.A., University of Stellenbosch.

1911. †Duthie, George, M.A., F.R.S.E. (Pres. D., 1911), Concession Siding, Private Bag, Salisbury, Rhodesia.

1912. Dwyer, E. W., B.A., Forest Department, Kingwilliamstown.

1916. Eadie, Duncan MacIntyre, 66, Currie Street, Durban, Natal.

1917. East London Public Library, East London.

1904. Eaton, William Arthur, 74, St. George's Street, Capetown.

1909. Edwards, Charles J., c/o Messrs. Heynes Mathew & Co., P.O. Box 242, Capetown.

1914. Elsdon-Dew, William, M.I.E.E., P.O. Box 4563, Johannesburg.

1910. †Engelenburg, *Dr.* F. V., Editor, *De Volksstem*, Pretoria.

1918. Epton, W. Martin, P.O. Box 2288, Johannesburg.

1910. Erskine, J. K., F.C.S., P.O., Willowdene, near Johannesburg.

1918. Evans, *Rev.* Gregory, The Priory, Rosettenville, Johannesburg.

1905. †EVANS, ILTYD BULLER POLE, M.A., B.Sc., F.L.S., (Pres. C, 1916), Chief of the Division of Plant Pathology, Department of Agriculture, P.O. Box 1294, Pretoria.

1905. EVANS, MAURICE SMETHURST, C.M.G., F.Z.S. (Pres. D., 1916), Hillcrest, Berea Ridge, Durban, Natal.

1905. †Evans, Samuel, 153, Nuggett, Street, Johannesburg.

1916. Evans, S., Modder B Gold Mining Co., Benoni, Transvaal.

1918. Evans, *Rev.* William Frederick, 14, Irwell Street, Observatory Road, Capetown.

Year of Election.

1914. Eveleigh, *Rev.* William, Seymour, C.P.
1904. Ewing, Sydney Edward Thacker, M.I.E.E., P.O. Box 2269, Johannesburg.
1906. Eyles, Frederick, F.L.S., M.L.C. (Pres. C., 1911), c/o Department of Agriculture, Salisbury, Rhodesia.

1915. Fairbridge, William Ernest, P.O. Box 56, Capetown.
1916. Falcon, William, M.A., Hilton College, Hilton Road, Natal.
1917. FANTHAM, HAROLD BENJAMIN, M.A., D.Sc., A.R.C.S., F.Z.S. (Vice-Pres. D)., Professor of Zoology and Comparative Anatomy, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.
1905. Farrar, Edward, P.O. Box 1242, Johannesburg.
1914. Farrow, Frederick Denny, M.Sc., Rhodes University College, Grahamstown, C.P.
1916. Faure, Jacobus Christian, B.S., M.A., P.O. Box 502, Bloemfontein.
1905. Feetham, Richard, Sauer's Buildings, c/o Loveday and Market Streets, Johannesburg.
1915. Ferreira, Frederick Herbert, Resident Magistrate's Office, Herschel, C.P.
1903. Ffennell, R. W., c/o Central Mining and Investment Corporation, Ltd., 1, London Wall Buildings, London, E.C., England.
1915. Findlay, George Schreiner, 151, Esselen Street, Pretoria.
1916. Finlay, *Professor* James, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.
1913. FitzHenry, *Rev.* J., Bedford, C.P.
1912. FitzSimons, F. W., F.Z.S., F.R.M.S. (Pres. C. 1912), Director, Port Elizabeth Museum, Port Elizabeth, C.P.
1918. FitzSimons, *Mrs.*, Port Elizabeth Public Museum, Port Elizabeth, C.P.
1902. *Flack, *Rev. Canon* Francis Walter, M.A., The Rectory, Uitenhage, C.P.
1902. Flanagan, Henry George, F.L.S., Prospect Farm, Komgha, C.P.
1916. Fletcher, Richard Evelyn, King Edward VII School, Johannesburg.
1902. *†FLINT, *Rev.* WILLIAM, D.D. (GENERAL SECRETARY, Pres. D., 1910), Wolmunster Park, Rosebank, Capetown.
1902. *†FLOWERS, FRANK, C.E., F.R.G.S., F.R.A.S., P.O. Box 1878, Johannesburg.
1918. Foote, H. J., M.B., Ch.B., L.D.S., 38, Estcourt Buildings, Johannesburg.
1907. FOOTE, J. A., F.G.S., F.E.I.S. (GENERAL SECRETARY 1917-1918, Pres. D, 1913), Principal, Commercial High School, Plein Street, Johannesburg.

Year of Election.

1914. Ford, Thurston James, Secretary, De Beers Benefit Society, Kimberley, C.P.

1917. Forest Department, Union Buildings, Pretoria.

1914. Forsyth, Thomas M., M.A., D.Phil. (Pres. F.), Professor of Philosophy, Grey University College, Bloemfontein.

1914. Forsyth, *Mrs.* T. M., Eagle's Nest, P.O. Box 238, Bloemfontein.

1916. Fouché, Carl Hercules, M.A., P.O. Box 1176, Johannesburg.

1905. †Frames, P. Ross, P.O. Box 148, Johannesburg.

1906. †Frankenstein, *Miss* Adelia, B.A., 9, Knight Street, Kimberley, C.P.

1916. Fraser, John, J.P., P.O. Box 149, Pietermaritzburg.

1916. Freeland, Hubert, P.O. Box 2863, Johannesburg.

1902. Fremantle, Henry Eardley Stephen, M.A., F.S.S., Upper Avenue, Stellenbosch, C.P.

1916. Frerichs, J. A., Rand Club, Johannesburg.

1913. Frew, John, P.O. Box 1, Johannesburg.

1916. Frood, George Edward Bell, M.A., M.I.M.M., Mines Department, Bloemfontein.

1914. Frood, *Dr.* T. M., Rand Club, Johannesburg.

1902. *Fuhr, Harry A., A.M.I.C.E., Public Works Department, Bloemfontein.

1918. Fulton, James Renwick, South African Railways Offices, Johannesburg.

1907. Gairdner, *Dr.* J. Francis R., 754, Church Street, Arcadia, Pretoria.

1903. †Galpin, Ernest Edward, F.L.S., Mosdene, Naboomspruit, Transvaal.

1918. Gardner, Elinor Wright, Professor of Geology, University of Stellenbosch, C.P.

1915. Garlick, *Miss* Winifred Marguerite, Thornibrae, Green Point, Capetown.

1902. *†Gasson, William, F.C.S., Dutoitspan Road, Kimberley, C.P.

1915. Gatherer, John Frederick William, P.O. Box 433, Bloemfontein.

1904. Gellatly, John T. B., M.I.C.E., P.O. Box 37, Bethulie, O.F.S.

1918. George, Ernest, B.A., F.C.S., P.O. Box 1176, Johannesburg.

1917. †Gericke, Oney Mortimer, M.B., ChB., L.R.C.P., L.R.C.S., Officers' Mess, Cantonments, Potchefstroom, Transvaal.

1912. Gibson, Harry, J.P., F.S.A.A., P.O. Box 1643, 85, St. George's Street, Capetown.

Year of Election.

1916. Gibson, James Young, 380, Longmarket Street, Pietermaritzburg.
1917. Gie, Johan Coenraad, Dunkeld, Weltevreden Avenue, Glebe Road, Rondebosch, Capetown.
1902. *Gilchrist, John Dow Fisher, M.A., D.Sc., Ph.D., F.L.S., C.M.Z.S. (General Secretary, 1903-1908), Professor of Zoology, University of Capetown.
1917. Gilchrist, Thomas B., M.D., C.M., J.P., P.O. Box 161, Fordsburg, Transvaal.
1903. Gilchrist, W., M.S.A., Mariendahl, Mulder's Vlei, C.P.
1916. Gill, Harold Warren, B.Sc., F.I.C., Chief Resident Chemist, Magadi Soda Co., Lake Magadi, British East Africa.
1917. Gimkewitz, Fred., P.O. Box 28, Brakpan, Transvaal.
1910. Ginsberg, Franz, P.O. Box 3, Kingwilliamstown, C.P.
1916. Glyn, Charles, M.E., P.O. Box 110, Roodepoort, Transvaal.
1912. Goddard, Ernest James, B.A., D.Sc., Professor of Zoology, University of Stellenbosch, C.P.
1913. Goddard, *Mrs.* E. J., Stellenbosch, C.P.
1902. †Godfrey, *Rev.* Robert, M.A., Somerville Mission, Tsolo, C.P.
1917. Goffe, Edward, P.O. Box 1899, Johanesburg.
1916. Goldstein, Benjamin, L.D.S., Walter Mansions, Johannesburg.
1916. Goodall, Frederick, P.O. Box 909, Durban.
1917. Gordon, Webster Boyle, M.I.C.E., F.R.G.S., Britstown, C.P.
1904. Gorges, Edmond Howard Lacam, M.V.O., Administrator, South-West African Protectorate, Windhuk.
1915. Gould, Robert Howe, P.O. Box 4941, Johannesburg.
1913. Graça, Captain Alberto C. de Faria, Sub-Chefe de Estado Major, Quartel Geral, P.O. Box 485, Lourenço Marques.
1915. Graham, George Smith, Avondale, P.O. Box 40, Queenstown, C.P.
1908. Grant, Charles C., M.A., Education Department, Bloemfontein.
1914. Grant, William Frank, B.Sc., Normal College, Bloemfontein.
1907. Gray, Charles Joseph, Office of Inspector of Mines, P.O. Box 405, Krugersdorp, Transvaal.
1907. Gray, James, F.I.C., P.O. Box 5254, Johannesburg.
1917. Greathead, Percy, P.O. Box 4303, Johannesburg.
1915. Green, Henry Hamilton, D.Sc., F.C.S. (Vice-Pres. B.), Veterinary Laboratory, Onderstepoort, P.O. Box 593, Pretoria.
1916. Greenacre, Walter, "Waveney," Musgrave Road, Durban.
1916. Griffin, Joseph D., P.O. Box 2155, Johannesburg.

Year of Election.

1906. Grimmer, Irvine Rowell, Assistant General Manager, De Beers Consolidated Mines, Ltd., Kimberley, C.P.

1916. Grindley-Ferris, Vyvyan, Consolidated Gold Fields of South Africa, Ltd., Johannesburg.

1917. Grobbelaar, Coert Smit, M.A., Heemstede, Riebeek Street, Stellenbosch.

1912. Gubbins, John Gaspard, B.A., Ottoshoop, Transvaal.

1913. Gundry, Philip G., B.Sc., Ph.D., A.R.C.S., Professor of Physics, Transvaal University College, Pretoria.

1915. Gunn, David, P.O. Box 1013, Pretoria.

1905. †Gutsche, Phillipp, M.D., Villa Torrita, Kingwilliamstown, C.P.

1903. Gyde, Charles J., A.M.I.C.E., Public Works Department, Union Buildings, Pretoria.

1904. Haagner, Alwyn K., F.Z.S., Zoological Gardens, P.O. Box 754, Pretoria.

1916. Haig, W., c/o Messrs. Fraser & Chalmers, Ltd., Corner House, Johannesburg.

1907. Hall, Carl, A.M.I.C.E., F.G.S., 28, Club Arcade, Durban, Natal.

1910. Halm, Jacob K. E., Ph.D., F.R.S.E., Royal Observatory, C.P.

1917. Hamlin, Ernest John, B.Sc., P.O. Box 17, Stellenbosch, C.P.

1907. Hammar, August, 441, Burger Street, Pietermaritzburg, Natal.

1902. *Hancock, H., A.M.I.C.E., P.O. Box 192, Klerksdorp, Transvaal.

1903. †Hancock, Strangman, M.Am.I.M.E., Kennel Holt, Cranbrook, Kent, England.

1916. Hardenberg, Christiaan Bernhardus, M.A., New Hanover Rail, Natal.

1904. Harries, W. M., P.O. Pox 2189, Johannesburg.

1905. Harris, Lionel, M.E., B.Sc., 113, Sivewright Avenue, Doornfontein, P.O. Box 1311, Johannesburg.

1915. Harrison, Charles William Francis, F.R.G.S., F.R.S.S., Nel's Rust, Natal.

1916. Hastings, Isabel, Wykeham School, Pietermaritzburg.

1905. Hatchard, John George, F.R.A.S., P.O. Box 499, Bloemfontein.

1917. Hawkins, John Charles, A.M.I.C.E., A.M.I.Mech.E., P.O. Box 54, Vereeniging, Transvaal.

1916. Hawthorne, Sydney Charles James, P.O. Box 1161, Johannesburg.

1916. Hay, William, J.P., P.O. Box 521, Capetown.

Year of
Election.

1916. Heather, Henry James Shedlock, B.A., M.I.C.E., M.I.E.E., F.Am.I.E.E., Professor of Electrotechnics, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.

1916. Healey, John Edward, P.O. Box 2, Maraisburg, Transvaal.

1914. Henderson, *Miss* Janetta, c/o Dr. J. B. H. Ruthven, P.O. Box 6253, Johannesburg.

1902. *Henkel, John Spurgeon, Conservator of Forests, Pietermaritzburg.

1904. †Herdman, G. W., M.A., M.I.C.E., Assistant Director of Irrigation, Union Buildings, Pretoria.

1911. Hewetson, W. M., M.B., D.P.H., J.P., Sinoia, Southern Rhodesia.

1909. Hewitt, John, B.A., Director of the Albany Museum, Grahamstown, Cape.

1915. Hewitt, Strafford Smith, P.O. Box 192, Bloemfontein.

1905. Heymann, Alexander, M.Ph., M.Ch., M.A., P.O. Box 3427, Johannesburg.

1909. Heymans, *Dr.* G. M. A., 702, Church Street, Arcadia, Pretoria.

1918. Hill, *Rev.* Walter Francis, M.A., The Priory, Rosettenville, Johannesburg.

1917. Hilhorst, Henri, P.O. Box 484, Pretoria.

1916. Hodges, Ruth Mary, B.Sc., Wykeham School, Pietermaritzburg.

1917. Hofmeyr, Jan Hendrik, M.A., Professor of Classics, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.

1914. Holdsworth, J. W., c/o Irrigation Department, Uitenhage, C.P.

1905. Holm, Alexander, Department of Agriculture, Pretoria.

1916. Holmes, George G., A.R.S.M., P.O. Box 1096, Johannesburg.

1915. Honey, Thomas, Superintendent, Municipal Gardens, P.O. Box 403, Lourenço Marques.

1902. †Honnold, W. L., Hyde Park Hotel, 66, Knightsbridge, London, S.W., England.

1902. *Horne, William James, A.M.I.C.E., A.M.I.E.E., Education Department, P.O. Box 432, Pretoria.

1902. *Hough, Sydney Samuel, M.A., F.R.S., Astronomer Royal, Royal Observatory, near Capetown.

1916. Hughes, Archibald Charles, Rand Club, Johannesburg.

1917. Hull, John William, P.O. Box 1178, Capetown.

1905. †Humphrey, William Alvara, B.A., Ph.D., F.G.S., Vryheid, Natal.

1912. Hunt, Donald Rolfe, Sub-Native Commissioner, Secocoeniland, *via* Lydenburg, Transvaal.

Year of Election.

1913. Hutcheon, James, M.A., F.R.S.G.S., P.O. Box 1176, Johannesburg.
1916. Hutton, C.E., P.O. Box 164, Germiston, Transvaal.
1916. Hutton, Jessie Margaret, St. George's Orphanage, Harrington Street, Capetown.
1917. Hynd, John, P.O. Box 44, Bulawayo.

1916. Imroth, G., Johannesburg Consolidated Investment Buildings, Johannesburg.
1918. Industries Section, Department of Mines and Industries, Union Buildings, Pretoria.
1913. Ingham, William, M.I.C.E., M.I.M.E. (Vice President, Vice Pres. A), Chief Engineer's Office, Rand Water Board, P.O. Box 1703, Johannesburg.
1907. Innes, *Hon.* Sir James Rose-, K.C.M.G., B.A., LL.B., Chief Justice of the Union of South Africa, Capetown.
1902. ***INNES, ROBERT THORBURN AYTON**, F.R.A.S., F.R.S.E. (General Secretary, 1909-1912; President, 1915), Union Observatory, Johannesburg.
1908. Institute of Government Land Surveyors, Cape of Good Hope Savings Bank Buildings, Capetown.

1916. Jackson, *Hon. Justice* Cecil Gower, 185, Prince Alfred Street, Pietermaritzburg.
1915. Jackson, Harry Percival, M.Sc., Jeppe High School, Johannesburg.
1915. Jackson, Percy, 28, Floss Road, Kensington, Johannesburg.
1914. Jacot, Edouard, B.A., Lecturer in Physics, University of Capetown.
1904. Jagger, J. W., F.S.S., M.L.A., P.O. Box 258, Capetown.
1915. Janse, Antonius Johannes Theodorus, F.E.S., Lecturer in Biology, Normal College, Pretoria, 1st Street, Gezina, Pretoria.
1917. Jardine, Alfred Edward, M.E., P.O. Box 107, East Rand, Transvaal.
1911. Jarvis, E. M., F.R.C.V.S., Jelf Estate, P.O. Box 14, Umtali, Rhodesia.
1910. Jeffery, John, c/o Standard Bank of South Africa, Ltd., 10, Clements Lane, London, E.C. 4, England.
1916. Jenner, Alice, Girls' High School, Oudtshoorn, C.P.
1903. Jennings, Hennen, 2221, Massachusetts Avenue, Washington, U.S.A.
1913. Jensen, Axel Emil, 24, Maddison Street, Jeppestown, Johannesburg.
1916. Jensen, Ragnvald, C.E., P.O. Box 1361, Johannesburg.
1916. †Joel, Solomon Barnato, P.O. Box 433, Johannesburg.
1912. Johnson, *Miss* Alta, Ph.B., New Street, Wellington, C.P.

Year of Election.

1912. Johnson, George Lindsay, M.A., M.D., 5 and 6, Castle Mansions, Eloff Street, Johannesburg.
1909. Johnson, W., L.R.C.P., L.R.C.S., 3, Link Road, Bloemfontein.
1914. Johnson, W. S., M.A., Professor of English, Grey University College, Bloemfontein.
1915. Jolly, William Adam, M.B., Ch.B., D.Sc., Professor of Physiology, University of Capetown.
1917. Jones, Daniel Johnes, Government School, Roodepoort, Transvaal.
1916. Jones, J. E., P.O. Box 2354, Johannesburg.
1917. †Jones, Levi David, B.Sc., 57, Long Street, Germiston, Transvaal.
1911. Joubert, M. J., B.Sc.Agr., Department of Agriculture, Bloemfontein.
1905. †Junod, *Rev.* Henri A., P.O. Box 21, Lourenço Marques.
1903. †JURITZ, CHARLES FREDERICK, M.A., D.Sc., F.I.C. (PRESIDENT, Pres. B, 1909, GENERAL SECRETARY, 1910-1917), Agricultural Chemical Research Laboratory, Department of Agriculture, Capetown.

1907. Kanthack, Francis Edgar, C.M.G., M.I.C.E., M.I.M.E., (Pres. A, 1915), Director of Irrigation, Union Buildings, Pretoria.
1912. Kehoe, D., M.R.C.V.S., P.O. Box 593, Pretoria.
1903. Kent, *Professor* Thomas Parkes, M.A., University of Capetown.
1915. Kenway, Harold Cecil, Public Works Department, Pretoria.
1905. King, Austin, Director of Mines, Macequeçe, Portuguese East Africa.
1915. King, Edith Louise Mary, Eunice High School, Bloemfontein.
1915. King, Francis Edward, P.O. 802, Pretoria.
1916. King, James, Lynedoch, Nottingham Road, Natal.
1914. KINGON, *Rev.* JOHN ROBERT LEWIS, M.A., F.R.S.E., F.L.S., (Vice Pres. E.), St. Andrew's Manse, 7, Victoria Park Drive, South End, Port Elizabeth.
1913. KIRKLAND, JOHN WILKINSON, M.Am.I.E.E., P.O. Box 1905, Johannesburg.
1907. Kirkman, John, J.P., M.P.C., 331, Musgrave Road, Durban.
1916. Kleudgen, Cæsar, P.O. Box 1164, Johannesburg.
1915. Klooster, Willem, 576, Church Street, Arcadia, Pretoria.
1902. *†Knapp, Arthur D., Chikondi Estate, Neno Post Office, British Central Africa.
1902. Kolbe, *Rev.* Frederick Charles, B.A., D.D., St. Mary's Presbytery, Capetown.

Year of Election.

1903. Kotze, *Sir* Robert W. N., Kt., B.A., P.O. Box 1132, New Law Courts, Johannesburg.
1918. Krause, Frederick Edward Trangott, B.A., LL.D., K.C., P.O. Box 2345, Johannesburg.
1916. Krause, Herbert Louis, A.S.M., P.O. Box 193, Germiston, Transvaal.
1917. Krige, Jacob Daniel Alphonse, Ph.D., Professor of Dutch, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.

1917. Laidler, Percy Ward, L.D.S., L.R.C.P., L.R.C.S., F.S.A., Seaford, Main Road, Sea Point, Capetown.
1916. Lamont, William John, Grootfontein School of Agriculture, Middelburg, C.P.
1913. Landau, Nathan, Survey Office, Modder Deep Level, P.O. Box 326, Benoni, Transvaal.
1914. Lange, *Hon. Justice Sir* Johannes H., Kt., LL.B., Judge's Chambers, Kimberley, C.P.
1916. Lanyon, John E., P.O. Box 25, Benoni, Transvaal.
1903. Legat, C. E. (Pres. C.), Chief Conservator of Forests, Pretoria.
1904. Leech, *Dr.* John Richard, Union Club, P.O. Box 1112, Johannesburg.
1904. †Leeds, R. Q., P.O. Box 928, Johannesburg.
1903. Legat, C.E., Department of Agriculture, Pretoria.
1907. Lehfeldt, Robert A., B.A., D.Sc. (Vice Pres. F, GENERAL TREASURER, 1909-1910), Professor of Physics, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.
1908. LEIGHTON, JAMES, F.R.H.S., P.O. Box 86, Kingwilliamstown, C.P.
1902. *Lenz, Otto, P.O. Box 92, Johannesburg.
1918. Le Roy, *Rev.* Albert E., B.A., B.D., Adams Mission Station, Natal.
1916. Leslie, Charles Duff, P.O. Box 1167, Johannesburg.
1916. †LESLIE ROBERT, M.A., F.S.S., Jagger Professor of Economics, University of Capetown.
1903. Leslie, T. N., C.E., F.G.S., P.O. Box 23, Vereeniging, Transvaal.
1908. Leviseur, M., Bloemfontein.
1905. †Lewis, *Mrs.* Helen R., P.O. Box 617, Johannesburg.
1903. †Lewis, Leon, P.O. Box 617, Johannesburg.
1917. Lindsay, Alan, P.O. Box 74, Pretoria.
1916. Linscott, Arthur Burrow, A.M.I.C.E., A.M.I.M.E., P.O. Box 4013, Johannesburg.
1918. Lister, Frederick Spencer, M.R.C.S., L.R.C.P., "Cranbrook," Jan Smuts Avenue, Westcliff, Johannesburg.
1916. Loeser, *Dr.* H. F., Crown Mines, Ltd., Johannesburg.

Year of Election.

1903. Logeman, William H., M.A., Professor of Physics, Grey University College, Bloemfontein.

1916. LORAM, CHARLES TEMPLEMAN, M.A., LL.B., Ph.D., Education Department, Maritzburg, Natal.

1903. Lorentz, Henri, P.O., Box 55, Johannesburg.

1902. Lounsbury, Charles Pugsley, B.Sc., F.E.S., (Pres. C, 1915), Chief of the Division of Entomology, Department of Agriculture, P.O. Box 513, Pretoria.

1902. *Lunt, Joseph, D.Sc., F.I.C., Royal Observatory, C.P.

1914. Lyle, James, M.A., Grey College School, Bloemfontein.

1902. *Lynch, *Major* F. S., J.P., Kimberley Waterworks Co., Ltd., P.O. Box 630, Kimberley, C.P.

1917. Lyons, Joseph, A.R.C.S., Grootfontein School of Agriculture, Middelburg, C.P.

1905. †McArthur, Duncan Campbell, M.R.C.S., L.R.C.P., Muizenberg, Capetown.

1917. MacColl, *Rev.* John A., M.A., The Manse, Mowbray, Capetown.

1917. McCrae, John, Ph.D., F.I.C., P.O. Box 1080, Johannesburg.

1917. McCracken, John, c/o Messrs. Fraser & Chalmers, Corner House, Johannesburg.

1916. McDavid, W., Trades School, Smit Street, Johannesburg.

1916. McDonald, David Paterson, M.A., B.Sc., P.O. Box 1176, Johannesburg.

1909. Macdonald, G., M.A., Normal Training College, Bloemfontein.

1902. *McEwen, T. S., A.M.I.C.E., "The Links," Rondebosch, C.P.

1908. MACFAYDEN, WILLIAM ALLISON, M.A., LL.D. (Vice Pres. F.), Professor of Philosophy, Transvaal University College, Pretoria.

1909. McFeggans, Alexander, P.O. Box 26, Umtata, C.P.

1914. McGregor, *Rev.* Andrew Murray, M.A., B.D., Blommestein, Three Anchor Bay, Capetown.

1918. MacIntyre, Alexander Stewart, Government Industrial School, Maseru, Basutoland.

1916. MacIntyre, Joseph Mansfield Bell, M.A., Twist Street, Government School, Johannesburg.

1916. McKay, *Mrs.* Helen Millar, Malvern Government School, Johannesburg.

1904. McKenzie, Archibald, M.D., C.M., M.R.C.S., Glen Lyon, Musgrave Road, Durban, Natal.

1917. MacLachlan, James, P.O. Box 1876, Johannesburg.

1917. McLaren, James, M.A., Calderwood, Herschel Walk, Wynberg, C.P.

Year of Election.

1915. †McLoughlin, Alfred George, Chief Magistrate's Office, Umtata, C.P.

1916. McLove, I. G., P.O. Box 899, Johannesburg.

1914. Macmillan, William Miller, B.A., Professor of History, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.

1913. Macpherson, Henry Wingate, P.O. Box 519, Johannesburg.

1908. Macrae, H. J., P.O. Box 817, Johannesburg.

1910. Malan, *Hon.* François Stephanus, B.A., LL.D., M.L.A., P.O. Box 450, Pretoria.

1912. †MALHERBE, D. F. DU TOIT, M.A., Ph.D., Professor of Chemistry, Transvaal University College, Pretoria.

1904. Malherbe, H.L., P.O. Box 208, Pretoria.

1917. Malherbe, Willem Elisa, B.A., B.Sc., Professor of Physics, University of Stellenbosch.

1917. Malleson, Percy Rodburd, F.R.H.S., Ida's Valley, Stellenbosch, C.P.

1902. †MALLY, CHARLES WILLIAM, M.Sc., F.E.S., F.L.S., Division of Entomology, Department of Agriculture, Capetown.

1915. Manning, Charles Nicolson, P.O. Box 98, Pietersburg, Transvaal.

1915. Marchand, Bernard de Coligny, B.A., D.Sc., Chemical Laboratory, Department of Agriculture, Pretoria.

1904. Marks, *Hon. Senator* Samuel, Hatherley Buildings, P.O. Box 379, Pretoria.

1902. *†**MARLOTH, Professor RUDOLF**, M.A., Ph.D. (Pres B, 1903, PRESIDENT, 1914), P.O. Box 359, Capetown.

1916. Marshall, William Benjamin, P.O. Box 159, Pietermaritzburg.

1904. †Marshall, W. S., P.O. Box 3055, Johannesburg.

1916. Martyn, J. F., 13, Kock Street, Johannesburg.

1911. Maufe, Herbert Brantwood, B.A., F.G.S., P.O. Box 366, Salisbury, Rhodesia.

1902. Melle, G. J. McCarthy, M.B., C.M., Robertson, C.P.

1903. Mellor, Edward, T., D.Sc., M.I.M.M., F.G.S., P.O. Box 1056, Johannesburg.

1902. *MENMUIR, R. W., A.M.I.C.E., National Mutual Buildings, Church Square, Capetown.

1917. Mercier, David Pyne, B.A., Secondary School, Winburg, O.F.S.

1914. Mesham, Paul, M.A., M.Sc., Natal University College, Pietermaritzburg, Natal.

1902.*†**METCALFE, Sir CHARLES**, Bart., M.I.C.E. (PRESIDENT, 1904; Pres. C, 1903), 21, Pall Mall, London, S.W., England.

Year of Election.

1916. Meyer, Edward C. J., B.Sc., P.O. Box 57, East Rand, Transvaal.
1917. Miller, Thomas Maskew, P.O. Box 396, Capetown.
1917. Mills, Frederick William, M.I.E.E., Headquarters, South African Railways, Johannesburg.
1915. Mitchell, David Thomas, M.R.C.V.S., Veterinary Research Office, P.O. Box 405, Department of Agriculture, Maritzburg, Natal.
1916. Mitchell, Hugh, P.O. Box 98, Langlaagte, Transvaal.
1916. MITCHELL,, JOHN, Jeppes Central Government School Johannesburg.
1918. Mitchell, William John, P.O. Box 1696, Johannesburg.
1915. Mogg, Albert Oliver Dean, B.A., P.O. Box 1294, Pretoria.
1917. Moir, James, M.A., D.Sc., F.I.C., P.O. Box 1080, Johannesburg.
1912. Moll, *Dr.* A. M., P.O. Box 4708, Johannesburg.
1918. Montgomery, Robert Eustace, M.R.C.V.S., Director of Veterinary Research, P.O. Box 593, Pretoria.
1916. Moore, Mary Elizabeth Constance, Wykeham School, Pietermaritzburg.
1903. Morice, George T., B.A., K.C., 48, Sauer's Buildings, Johannesburg.
1916. MORRISON, JOHN TODD, M.A., B.Sc., F.R.S.E., A.M.I.E.E. (Pres. A.), Professor of Applied Mathematics, Victoria College, Stellenbosch.
1912. Mortimer, *Capt.*, W., M.R.C.S., No. 7, Military Hospital, Wynberg, C.P.
1916. Morton, David Thomas, West Rand Consolidated Mines, Transvaal.
1917. MOSS, CHARLES EDWARD, M.A., D.Sc., F.L.S., F.R.G.S. (Vice Pres. C.), Professor of Botany, South African School of Mines and Technology, Johannesburg.
1915. Mudd, Norman, M.A., Grey University College, Bloemfontein.
1902. ***MUIR, Sir THOMAS,** Kt., C.M.G., M.A., LL.D., F.R.S., F.R.S.E. (PRESIDENT, 1910), Elmcote, Sandown Road, Rondebosch, C.P.
1915. Munro, Hugh Kenneth, Division of Entomology, P.O. Box 513, Pretoria.
1913. Munro, James, P.O. Box 19, Lourenço Marques.
1916. Munro, John, P.O. Box 433, Johannesburg.
1917. Murray, Charles, M.A., Department of Education, Capetown.
1904. Murray, George Alfred Everett, M.D., F.R.C.S., L.R.C.P., P.O. Box 105, Johannesburg.
1911. Musselwhite, *Rev.* E. W. H., B.A., Zonnebloem College, Capetown.

Year of Election.

1916. Nance, Francis James, Office of Engineer-in-Chief, South African Railways, Johannesburg.
1916. Narbeth, Benjamin Mason, B.Sc., F.C.S., Principal, Technical College, Durban.
1910. Nauta, *Prof.* Renicus Dowe, University of Capetown.
1917. Nay, Arthur Mac, M.I.Mech.E., P.O. Box 951, Durban.
1916. Neame, Hugh Austin, P.O. Box 3921, Johannesburg.
1917. Neethling, *Prof.* Johannes Henoch, M.Sc., University of Stellenbosch, C.P.
1905. Neilson, A. M., Manager, Safco Fertilizers Co., Umbilo, Natal.
1916. Neitz, *Rev.* Johannes, P.O. Box 19, Potgietersrust, Transvaal.
1915. New York Public Library, 42nd Street and Fifth Avenue, New York City, U.S.A.
1917. Newbery, H., P.O. Box 16, Knights, Transvaal.
1914. Newhall, Percy Melrose, B.Sc., P.O. Box 485, Johannesburg.
1916. Newhouse, Hans, P.O. Box 1156, Johannesburg.
1916. Newman, Arthur Dudley, P.O. Box 231, Johannesburg.
1918. Newton, Francis James, M.A., The Treasury, Salisbury, Rhodesia.
1917. Nicholson, Alfred, Schoongezicht, Stellenbosch, C.P.
1902. *Nicholson, *Colonel* George Taylor, M.I.C.E., Resident Engineer, Docks, Capetown.
1913. Nicol, John, M.R.C.V.S., Government Veterinary Surgeon, P.O. Box 99, Kingwilliamstown.
1917. Nicolson, John Gregory, F.G.S., P.O. Box 181, Krugersdorp, Transvaal.
1916. Niven, James Just, M.I.C.E., M.R.San.I., P.O. Box 205, Pietermaritzburg.
1904. Nixon, Edward John, M.R.C.S., L.R.C.P., P.O. Box 57, Heidelberg, Transvaal.
1902. Nobbs, Eric Arthur, Ph.D., B.Sc., F.R.H.S., Director of Agriculture, Salisbury, Rhodesia.
1915. Norton, *Rev.* William Alfred, B.A., B.Litt. (Pres. E), Glenwood, Avenue Road, Rondebosch, Capetown.

1905. †Oats, Francis, F.G.S., Director, De Beers Consolidated Mines, Ltd., Kimberley, Cape Province.
1908. O'Connor, James, Railway Hotel and Stores, Ashton, Cape.
1917. Odgers, W., Rand Club, Johannesburg.
1907. Ogg, Alexander, M.A., B.Sc., Ph.D. (Pres. A, 1914), Professor of Physics, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.
1918. Ordbrown, Albert Edward, P.O. Box 2895, Johannesburg.
1915. ORENSTEIN, ALEXANDER JEREMIAH, M.D., M.R.C.S., L.R.C.P., P.O. Box 1056, Johannesburg.

Year of Election.

1914. Orford, *Rev. Canon* Horace William, M.A., Ficksburg, Orange Free State.

1906. Orpen, Joseph Millerd, Mon Asile, 43, St. Mark's Road, East London.

1902. * **ORR, JOHN**, B.Sc., M.I.C.E., M.I.Mech.E. (PRESIDENT, 1917, Pres. A, 1916), Professor of Mechanical Engineering, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.

1913. Orr, *Mrs.* J., c/o Professor Orr, P.O. Box 1176, Johannesburg.

1918. Ortlepp, Reinhold Johannes, M.A., P.O. Box 1176, Johannesburg.

1916. Otto, Cyril Saxon Douglas, Otto's Bluff, Natal.

1917. Ottley, Thomas George, P.O. Box 2671, Johannesburg.

1905. †Paisley, William, M.B., B.Ch., P.O. Box 127, Queenstown, Cape.

1908. Palmer, W. Jarvis, B.Sc.A., P.O. Box 4557, Johannesburg.

1905. †Papenfus, H. B., K.C., P.O. Box 5155, Johannesburg.

1914. Parry, John, c/o De Beers Mines, Ltd., 17, Hull Street, Kimberley.

1912. Paterson, *Mrs.* T. V., Redhouse, near Port Elizabeth.

1916. Paterson, William, 103, Eloff Street, Johannesburg.

1902. †Pattrick, C. Beaufoy, A.M.I.C.E., King Edward Mansions, Port Elizabeth, C.P.

1903. †Payne, Albert E., A.R.S.M., P.O. Box 15, Langlaagte, Transvaal.

1916. Pearce, William, Lower Illovo, Natal.

1916. Pellissier, *Rev.* George Murray, B.A., B.D., 7, Langham Street, Pietermaritzburg.

1913. Pepulim, *Dr.* D., P.O. Box 704, Lourenço Marques.

1913. Perez, Manoel A. Jr., Chief Assistant, Observatorio Campos Rodriguez, P.O. Box 256, Lourenço Marques.

1907. Péringuey, Louis Albert, D.Sc., F.E.S., F.Z.S., Director South African Museum, Capetown.

1910. †Perold, Abraham Izak, B.A., Ph.D., Professor of Viticulture and Oenology, University of Stellenbosch.

1912. Perrins, George Richard, "Grange," 106, Cape Road, Port Elizabeth, C.P.

1905. Petersen Carl Olief, P.O. Box 4938, Johannesburg.

1917. Petersen, Henry Alfred, P.O. Box 3696, Johannesburg.

1917. Petrie, Alexander, M.A., Professor of Classics, Natal University College, Pietermaritzburg, Natal.

1915. Pettey, Franklin William, B.A., Entomologist, Government School of Agriculture, Elsenburg, Mulder's Vlei, C.P.

Year of Election.

1904. Pettman, *Rev.* Charles, Wesleyan Parsonage, Chapel Street, Kimberley, C.P.
1918. Philip, David R. C., P.O. Box 143, Johannesburg.
1915. Phillips, Edwin Percy, M.A., D.Sc., F.L.S., P.O. Box 1294, Pretoria.
1916. Phillips, Martin, M.A., P.O. Gezina, Pretoria.
1912. Pickstone, Harry Ernest Victor, Lekkerwyn, Groot Drakenstein, C.P.
1917. Pijper, *Dr.* Cornelis,, P.O. Box 21, Lydenburg, Transvaal.
1903. Pim, Howard, B.A., F.C.A. (General Treasurer, 1906-1907), P.O. Box 1331, Johannesburg.
1915. Plowman, George Thomas, C.M.G., Provincial Secretary, Pietermaritzburg.
1915. Pollard, Miss Grace E., F.R.H.S., Huguenot College, Wellington, C.P.
1918. Porter, Annie (Mrs. H. B. Fantham), D.Sc., F.L.S., P.O. Box 1038, Johannesburg.
1916. Pott, Ethel K. A., St. John's College, Johannesburg.
1918. Potter, Henry Samuel, M.I.Mech.E., P.O. Box 5510, Johannesburg.
1916. Potts, Alexander, P.O. Box 2863, Johannesburg.
1905. †Potts, George, M.Sc., Ph.D. (Pres. C, 1914), Professor of Botany, Grey University College, 91, Park Road, Bloemfontein.
1916. Powell, Owen Price, P.O. Box 192, Germiston, Transvaal.
1916. Price, Bernard, M.I.E.E., A.M.I.C.E., A.M.Am.I.E.E., P.O. Box 2671, Johannesburg.
1916. Price, Roger, P.O. Box 1242, Johannesburg.
1913. Provay, Giuseppe, Chief Electrical Engineer of Harbours and Railways, P.O. Box 1479, Lourenço Marques.
1910. Purcell, William Frederick, M.A., Ph.D., C.M.Z.S., Bergvliet, Diep River, C.P.
1917. Purchas, Thomas Alfred Rufus, P.O. Box 272, Johannesburg.
1906. Pym, Frank Arthur Oakley, Public Museum, P.O. Box 51, Kingwilliamstown, C.P.

1902. †Quinan, Kenneth B., Chemist and Engineer, Cape Explosive Works, Somerset West, C.P.

1915. Ramsbottom, Kathleen Nora, B.A., Eunice High School, Bloemfontein.
1916. Read, Herbert Alfred, F.R.S.A., P.O. Box 1056, Johannesburg.
1916. Reeve, Herbert C., M.A., High School, Krugersdorp, Transvaal.
1902. *Reid, Arthur Henry, F.R.I.B.A., F.R.San. I. (Vice-President), P.O. Box 120, Capetown.

Year of Election.

1914. Reid, Walter, F.R.I.B.A., P.O. Box 746, Johannesburg.
1917. Reinecke, Theodore Gerald Wellesley, B.A., M.Sc., School of Agriculture, Elsenburg, Mulder's Vlei, C.P.
1916. Reunert, Jack, Messrs. Reunert & Lenz, Consolidated Buildings, Johannesburg.
1902. ***REUNERT, THEODORE**, M.I.C.E., M.I.M.E., (PRESIDENT, 1905), P.O. Box 92, Johannesburg.
1905. Reunert, *Mrs.* Theodore, P.O. Box 92, Johannesburg.
1907. Reuter, *Rev.* Fritz L., Medigen, P.O. Duivel's Kloof, *via* Pietermaritzburg, Natal.
1903. †Reyersbach, Louis J., 29 and 30, Holborn Viaduct, London, E.C.
1913. Reyneke, Andries Adriaan Louw, B.A., Durbanville, C.P.
1913. Reyneke, *Rev.* Jacobus Cornelius, De Pastorie, Cradock, C.P.
1916. Reynolds, *Sir* Frank, Umhlali, Esperanza, Natal.
1916. Reynolds, H., M.I.Mech.E., P.O. Box 92, Johannesburg.
1916. Reynolds-Tait, Joseph St. Guido, P.O. Box 502, Durban.
1916. Rice, Frank Peabody, P.O. Box 930, Johannesburg.
1916. Rich, Stephen Gottheil, M.A., B.Sc., Edendale, Natal.
1909. RINDL, MAX MORRIS, Ing.D. (Pres. B, 1917), Professor of Chemistry, Grey University College, Bloemfontein.
1903. Ritchie, William, M.A. (Pres. D, 1914), Professor of Latin, University of Capetown.
1916. Robb, Andrew D., Trades School, Smit Street, Johannesburg.
1917. Robb, A. Moir, M.A., P.O. Box 4439, Johannesburg.
1902. ***ROBERTS, ALEXANDER WILLIAM**, D.Sc., F.R.A.S., F.R.S.E. (Pres. A 1908; PRESIDENT, 1913), Lovedale, C.P
1915. Roberts, Austin, P.O. Box 413, Pretoria.
1914. Roberts, John Lloyd, P.O. Box 529, Salisbury, Rhodesia.
1913. Roberts, *Rev.* Noel (Pres. E, 1917), The Vicarage, Orchards, Johannesburg.
1909. Robertson, Colin C., M.F., c/o Forest Department, Pretoria.
1906. Robertson, John, P.O. Box 138, Bloemfontein.
1915. Robinson, Eric Maxwell, M.R.C.V.S., P.O. Box 593, Pretoria.
1902. †Rogers, Arthur William, M.A., Sc.D., F.G.S. (Pres. B, 1910), P.O. Box 206, Heidelberg, Transvaal.
1918. Rogers, *Ven. Archdeacon* Frederick Arundel, P.O. Box 1131, Johannesburg.
1915. Romyn, *Mrs.* Elizabeth, Zonnehoek, 157, Troye Street, Pretoria.
1902. *Rose, James Wilmot Andreas, M.I.C.E., Municipal Offices, Stellenbosch, C.P.
1905. †Rose, *Lieut.-Col.* John George, D.S.O., F.C.S., Government Chemical Laboratory, Capetown.

Year of Election.

1912. Roseveare, W. N., M.A. (Vice-President; Pres. A, 1917), Professor of Mathematics, Natal University College, P.O. Box 375, Pietermaritzburg.
1917. Ross, Charles Richard, Forest Department, Capetown.
1914. Ross, John, P.O. Box 636, Kimberley.
1917. Ross, John Carl, B.A., M.S., Ph.D., School of Agriculture, Elsenburg, Mulder's Vlei, C.P.
1902. *Runciman, William, M.L.A., Simonstown, C.P.
1915. Ruthven, Jane Buchanan Henderson, M.D., L.R.C.P., L.R.C.S., F.R.S.A., P.O. Box 6253, Johannesburg.

1918. Satchel, Oscar John Soley, M.A., Boys' High School, Kimberley, C.P.
1915. Schlupp, William Francis, B.Sc., Lecturer in Zoology and Entomology, Government School of Agriculture, P.O. Box 181, Potchefstroom, Transvaal.
1917. Schoch, Edward Rengers, M.I.M.M., P.O. Rooiberg, Transvaal.
1902. *Schönland, Selmar, M.A., Ph.D., F.L.S., C.M.Z.S., (Pres. C., 1908), Professor of Botany, Rhodes University College, Grahamstown, C.P.
1913. School of Agriculture, Cedara, Natal.
1913. School of Agriculture, Elsenburg, Mulder's Vlei, C.P.
1913. School of Agriculture and Experimental Farm, Glen, O.F.S.
1913. School of Agriculture and Experimental Station, Grootfontein, Middelburg, C.P.
1913. School of Agriculture and Experimental Farm, Potchefstroom, Transvaal.
1916. Schreiber, Oscar Albert Egmont, P.O. Box 396, Pietermaritzburg.
1914. Schreiner, *Rt. Hon.* William Philip, M.A., M.L., South African Chambers, Capetown.
1916. Schulz, Aurel, M.D., Krantz Kloof, Main Line, Natal.
1902. Schwarz, Ernest H. L., A.R.C.S., F.G.S. (Pres. B., 1908), Professor of Geology, Rhodes University College, P.O. Box 116, Grahamstown, C.P.
1916. Scott, *Rev.* James, Claridge, Natal.
1914. Searle, *Mrs.* Amy M., B.A., Great Brak River, C.P.
1912. Seruya, Salomon, Vice-Consul for Portugual, P.O. Box 5633, Johannesburg.
1912. Shand, Samuel James, Ph.D., D.Sc., F.G.S., Professor of Geology, University of Stellenbosch, C.P.
1903. Shanks, Robert, 20, Graf Street, Johannesburg.
1916. Sheridan, Norman, M.D., B.S., Chudleigh's Buildings, Johannesburg.
1916. Sherwell, Percy W., City Deep Gold Mining Co., Johannesburg.
1916. Shore, John, P.O. Box 2997, Johannesburg.

Year of Election.

1902. *Shores, J. W., C.M.G., M.I.C.E., Rutland, Scottsville, Pietermaritzburg, Natal.
1916. Siedle, Otto, P.O. Box 931, Durban, Natal.
1916. Sim, Thomas Robertson, 168, Burger Street, Pietermaritzburg.
1916. †Simon, Frank, M.I.M.E., P.O., Minnaar, Transvaal.
1917. Simons, Lewis, B.Sc., University of Capetown.
1916. Simpson, Archibald James Grant, A.M.I.E.E., P.O. Box 239, Capetown.
1917. Skaife, Sydney Harold, B.A., Government Experimental Station, Rosebank, Capetown.
1902. *Smartt, *Hon. Sir* Thomas William, K.C.M.G., L.R.C.S.I., L.K.Q.C.P.I., M.L.A., Glen Bân, Stellenbosch, C.P.
1916. Smith, Arthur Herbert, P.O. Box 141, Durban.
1916. Smith, *Hon.* Charles G., P.O. Box 43, Durban.
1915. SMITH, EDWARD HOLMES, B.Sc., School of Agriculture, P.O. Box 181, Potchefstroom, Transvaal.
1906. Smith, Frank Braybrooke, Secretary for Agriculture, Union Buildings, Pretoria.
1915. Smith, Frank Cumming, Grootfontein School of Agriculture, Middelburg, C.P.
1917. Smith, *Sir* Frederick William, Kt., P.O. Box 84, Capetown.
1912. Smith, George William, A.M.I.C.E., 11, Constitution Hill, Port Elizabeth, C.P.
1903. Smith, James, M.A., Normal College, Capetown.
1917. Smith, Johannes Jacobus, B.A., Professor of French and German, University of Stellenbosch.
1905. Smuts, *Lieut.-General Rt. Hon.* Jan C., B.A., LL.D., Minister of Defence, P.O. Box 1081, Pretoria.
1914. †Smyth, *Right Rev. Bishop* William Edmund, M.A., M.B., c/o English Church House, 61, Burg Street, Capetown.
1916. Smyth, Robert Milner, F.R.C.S., L.R.C.P., F.R.I.P.H., Government Hospital, Durban.
1903. Solly, *Mrs.* Julia F., Knor Hoek, Sir Lowry's Pass, C.P.
1903. Solomon, *Hon. Justice Sir* W. H., High Court of Appeal, Capetown.
1908. Somerville, Alfred James, M.A., P.O. Box 126, Salisbury, Rhodesia.
1910. †Soutter, John Lyall, P.O. Box 403, Pretoria.
1916. Sowter, Godfrey Dennis, P.O. Box 1020, Johannesburg.
1906. †Spencer, *Dr.* Henry Alexander, M.R.C.S., L.R.C.P., Middelburg, Transvaal.
1915. †Spensley, James Carter, M.A., Lecturer in Chemistry, Transvaal University College, Pretoria.
1905. Sperryn, Arthur James, J.P., P.O. Box 1, Ermelo, Transvaal.

Year of Election.

1903. Spilhaus, William, c/o Messrs. W. Spilhaus & Co., Strand Street, Capetown.

1913. Stafford, *Miss* Susan, M.A., Huguenot College, Wellington, C.P.

1905. Stallard, C. F., K.C., P.O. Box 5156, Johannesburg.

1905. Stanley, George Hardy, A.R.S.M., M.I.M.E., M.I.M.M., F.I.C. (Pres. B, 1914), Professor of Metallurgy and Assaying, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.

1904. Stead, Arthur, B.Sc., F.C.S., School of Agriculture, Grootfontein, Middelburg, C.P.

1908. Steedman, *Miss* E. C., M.A., Gando Farm, Gwelo, Southern Rhodesia.

1917. Stegmann, Ebenezer Theodorus, B.A., D.Sc., Lichfield, Stellenbosch, C.P.

1917. Stein, Philip, B.A., P.O. 1176, Johannesburg.

1917. †Stephens, Edith Layard, B.A., F.L.S., University of Capetown.

1903. Stevens, J. D., P.O. Box 1782, Johannesburg.

1909. Stewart, G. A., City Engineer, Bloemfontein.

1917. Stokes, Frank Torrens, M.I.Mech.E., P.O. Box 699, Johannesburg.

1905. †Stoneman, *Miss* Bertha, D.Sc., Huguenot College, Wellington, C.P.

1917. Storey, Francis Wylie, B.Sc., F.C.S., 31, Monument Road, Bloemfontein.

1902. *Stott, Clement H., F.G.S., M.S.A., P.O. Box 7, Pietermaritzburg, Natal.

1916. Strapp, Walter Russell, M.D., 248, Loop Street, Pietermaritzburg.

1904. Struben, A. M. A., A.M.I.C.E., P.O. Box 317, Pretoria.

1906. Stuart, James, 34, Loop Street, Pietermaritzburg.

1906. Stucke, W. H., P.O. Box 2271, Johannesburg.

1915. Swierstra, Cornelis Jacobus, F.E.S., P.O. Box 413, Pretoria.

1915. Swynnerton, Charles Francis Massy, F.L.S., F.E.S., F.R.H.S., Gungunyana, Melsetter, Southern Rhodesia.

1904. Syfret, S. B., B.A., M.B., B.C., Main Road, Mowbray, C.P.

1918. Taberer, Henry Melville, B.A., P.O. Box 1251, Johannesburg.

1905. †Tannahill, Thomas Findlay, M.D., C.M., D.P.H., Queenstown, C.P.

1918. Tannock, John Porter, M.B., C.M., D.P.H., P.O. Box 5315, Johannesburg.

1918. Tapscott, Sidney, B.Sc., "Tipperary," Riverton Road, C.P.

Year of Election.

1909. Teasdale, *Miss* Emma L., Government School, Maraisburg, Transvaal.
1913. Teixeira, *Capt.* Augusto D'Almeida, Observatorio Campos Rodrigues, P.O. Box 256, Lourenço Marques.
1906. Tennant, Sydney Dennison, P.O. Box 132, Ermelo, Transvaal.
1904. ***THEILER, Sir ARNOLD** K.C.M.G., D.Sc. (PRESIDENT, 1912), Department of Agriculture, Capetown.
1903. Thomas, Walwyn, B.C., M.B., B.A., 2, Greenham Villas, Annandale Street, Capetown.
1914. Thompson, Frederick Handel, B.A., Inspector of Schools, P.O. Box 4439, Johannesburg.
1916. Thompson, James, 6, Rissik Street, Johannesburg.
1913. Thomson, Samuel, C.A., P.O. Box 228, Johannesburg.
1902. Thomson, William, M.A., B.Sc., LL.D., F.R.S.E., Registrar, University of South Africa, Pretoria.
1910. Thornton, Russel William, Principal, Government School of Agriculture, Grootfontein, Middelburg, C.P.
1903. †Tietz, Heinrich C. J., M.A., Ph.D., Buona Vista, Burham Road, Observatory Road, C.P.
1917. Tindall, Rory Joseph Laidman, B.A., P.O. Box 4351, Johannesburg.
1916. Tomes, *Rev.* Alfred Edmund Godfrey, B.A., 181, Loop Street, Pietermaritzburg.
1902. *Townsend, Stephen Frank, C.E., Rhodesia Railways, Ltd., P.O. Box 215, Bulawayo, Rhodesia.
1917. Tribolet, Isaac, F.R.H.S., Elsenburg School of Agriculture, Mulder's Vlei, C.P.
1910. Trollip, W. L., Office of the Hon. the Administrator of the Cape Province, Capetown.
1917. Tromp, Felix Johan, B.A., F.C.S., Transvaal University College, Pretoria.
1906. Troup, James Macdonald, M.B., Ch.B., L.S.A., 230, Esselen Street, Sunnyside, Pretoria.
1916. TRUBSHAW, HENRY ARTHUR, Twelfth Avenue, Mayfair, Johannesburg.
1903. Tucker, William Kidger, C.M.G., P.O. Box 9, Johannesburg.
1916. Tucker, William Petre, Reunion Estate, Reunion, South Coast, Natal.
1916. Turner, F. E., P.O. Box 407, Johannesburg.
1906. Tyers, F. G., M.A., The College, P.O. Box 93, Potchefstroom, Transvaal.

1916. Udwin, M., Rand Water Board, Johannesburg.
1917. Union Department of Education, Pretoria.
1917. Union Observatory, c/o Union Astronomer, Johannesburg.

Year of Election.

1915. Van der Bijl, Paul Andries, M.A., D.Sc., F.L.S., Natal Herbarium, Berea, Durban.
1912. Van der Lingen, Jan Stephanus, B.A., Erinville, Milton Road, Sea Point, Capetown.
1917. Van der Merwe, Charl Daniel, B.A., Ph.D., Professor of Inorganic Chemistry, University of Stellenbosch, C.P.
1909. Van der Merwe, C. P., Government Entomologist, Point, Durban.
1910. VAN DER RIET, BERTHAULT DE ST. JEAN, M.A., Ph.D., (Pres. B, 1912), Professor of Chemistry, University of Stellenbosch, C.P.
1904. Van der Sterr, W. C., P.O. Box 1066, Johannesburg.
1917. VAN NIEKERK, JOHN, M.B., C.M., P.O. Box 473, Johannesburg.
1903. Vaughan, J. A., P.O. Box 1132, Johannesburg.
1917. Viljoen, Hendrik Geldenhuys, B.A., D.Litt., Market Street, Stellenbosch.
1916. Visser, Cornelis François, B.A., Ph.D., 130, Zastron Street, Bloemfontein.
1916. Visser, Wilhelmus Hendrikus, B.Sc., P.O. Box 231, Johannesburg.
1915. Von Mengershausen, Frederich Karl, B.Sc., Lecturer in Mining Engineering, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.
1903. Von Oppell, Otto Karl Adolf, Department of Lands, Pretoria.

1916. Wade, Walter B., P.O. Box 932, Durban.
1912. WAGER, HORACE ATHELSTAN, A.R.C.S., Professor of Botany and Zoology, Transvaal University College, Pretoria.
1916. Wagner, Percy Albert, Ing.D., B.Sc. (Pres. B.), P.O. Box 1277, Pretoria.
1913. Wahl, R. Owen, B.A., Grootfontein School of Agriculture, Middelburg, C.P.
1912. Walker, James, M.R.C.V.S., P.O. Box 593, Pretoria.
1917. Wallace, George, M.B., Ch.B., L.R.C.P., L.R.C.S., Dynamite Factory, Modderfontein, Transvaal.
1902. *Waller, Arthur H., A.M.I.C.E., F.R.Met.S., Town Engineer, Bulawayo, Rhodesia.
1902. *WALSH, ALBERT (GENERAL TREASURER, 1910-17), P.O. Box 39, Capetown.
1913. Walsh, Lionel Henry, Brackley, Kenilworth, Capetown.
1916. Walton, Arthur John, Rose Deep, P.O. Box 6, Germiston, Transvaal.
1914. Wark, *Rev.* David, M.A., D.D., The Manse, Woodley Street, Kimberley, C.P.

Year of Election.

1907. WARREN, ERNEST, D.Sc., Professor of Zoology, Natal University College, Pietermaritzburg, Natal.
1916. Waterhouse, Osborn, M.A., Professor of English and Philosophy, Natal University College, Pietermaritzburg.
1906. Watermeyer, Frederick Stephanus, P.O. Box 973, Pretoria.
1917. Watkin, Morgan, M.A., Ph.D., Professor of French, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.
1902. *Watkins, Arnold Hirst, M.D., M.R.C.S., M.L.A., (Pres. D, 1906), Ingle Nook, Kimberley, C.P.
1906. WATKINS-PITCHFORD, WILFRED, M.D., F.R.C.S., D.P.H., South African Institute for Medical Research, P.O. Box 1038, Johannesburg.
1916. Watson, Frederick William, B.Sc., F.I.C., P.O. Box 108, Germiston, Transvaal.
1914. Watson, Thomas Hunter, P.O., Box 1400, Capetown.
1915. Watson, William Cruickshank, 13, Yeo Street, Yeoville, Johannesburg.
1918. Watson, John, F.I.C., P.O. Box 1026, Johannesburg.
1906. Watt, Dugald Campbell, M.D., 131, Pietermaritzburg St., Pietermaritzburg, Natal.
1912. Way, William Archer, M.A. (Pres. D, 1912), Grey Institute, Port Elizabeth, C.P.
1914. Webb, George Arthur, A.I.E.E., M.S.A., P.O. Box 3136, Johannesburg.
1916. †Webber, Walter Solomon, B.A., P.O. Box 1088, Johannesburg.
1917. Weinberg, Leo, B.A., P.O. Box 1176, Johannesburg.
1911. Welch, *Rev.* Sidney Read, B.A., D.D., Ph.D., St. Mary's, Bouquet Street, Capetown.
1916. Wertheim, Louis, P.O. Box 354, Johannesburg.
1903. Wessels, *Hon. Justice Sir* J. W., Kt., B.A., LL.B., Pretoria.
1916. Wessels, Johannes Jacobus, M.E., P.O. Box 1392, Johannesburg.
1916. White, *Mrs.* E. L., King Edward Mansions, Port Elizabeth.
1902. †White, Miss Francis Margaret, Trescoe, Cornwall Place, Wynberg, C.P.
1910. White, H. A. (Vice-Pres. B), P.O. Dersley, *via* Germiston, Transvaal.
1902. †White, *Miss* Henrietta Mary, B.A., Trescoe, Cornwall Place, Wynberg, C.P.
1902. *White-Cooper, William, M.A., F.R.I.B.A., P.O. Box 11, Cradock, C.P.
1915. Whitmore, Sidney W., Public Works Department, Pretoria.
1909. Whitworth, Walter S., Koffyfontein Diamond Mine, O.F.S.

Year of Election.

1910. Wiener, Ludwig, F.R.G.S., Riebeek Street, P.O. Box 365, Capetown.
1904. Wilhelm, A. R. A., M.B., C.M., Barkly East, C.P.
1904. †Wilkinson, J. A., M.A., F.C.S. (Pres. B, 1916), Professor of Chemistry, South African School of Mines and Technology, P.O. Box 1176, Johannesburg.
1910. Wille, Friedrich Adolf, M.D., Ch.B., D.P.H., 11, Derby Road, Bertrams, Johannesburg.
1902. *Williams, Alpheus Fuller, B.Sc., Mining Engineer, De Beers Consolidated Mines, Ltd., P.O. Box 616, Kimberley, C.P.
1916. Williams, Charles Herbert, P.O. Box 2155, Johannesburg.
1912. Williams, Cornelius, B.Sc., A.R.C.S., Government School of Agriculture, Cedara, Natal.
1902. Williams, *Prof.* D., B.Sc., Rhodes University College, Grahamstown, C.P.
1902. ****WILLIAMS, GARDNER F.***, M.A., LL.D. (President, 1906), 2201, R. Street, N.W. Washington, D.C., U.S.A.
1917. Williams, John Elias, P.O. Box 3552, Braamfontein, Johannesburg.
1903. †Wilman, *Miss* M., McGregor Memorial Museum, Kimberley, C.P.
1903. †Wilson, Arthur Marius, M.D., B.S., L.R.C.P., M.R.C.S., Jesmond House, Hof Street, Capetown.
1916. Wilson, Charles Edmund, A.M.I.E.E., P.O. Box 930, Johannesburg.
1917. Wilson, James Hugh Elwes, P.O. Box 4303, Johannesburg.
1909. Windram, James Thomas, P.O. Box 3547, Johannesburg.
1912. Winter, *Rev.* Johannes August, Onverwacht, P.O., Sekukuni, District Lydenburg, Transvaal.
1903. †Winterton, Albert Wyle, F.C.S., Lemoenfontein, near Beaufort West, C.P.
1906. Wood, H. E., M.Sc., F.R.Met.S. (Vice President. Vice Pres. A. General Secretary 1913-1916), Union Observatory, Johannesburg.
1905. †Wood, James, M.A., P.O. Box 2, Kingwilliamstown, C.P.
1916. Woods, *Mrs.* Sarah Ann, 211, Commercial Road, Pietermaritzburg.
1916. Wright, Kathleen Margaret, B.Sc., High School for Girls, Barnett Park, Johannesburg.
1915. Wyatt, Stanley, M.Sc., Normal College, P.O. Box 855, Pretoria.
1916. Wylie, James Scott, K.C., Scotswood, Ridge Road, Durban.

1917. Yaldwyn, Sibert Halcott, Government School, Malvern (Denver Delivery), Johannesburg.
1917. Young, Allan Brownlie, P.O. Box 1242, Johannesburg.
1904. Young, *Professor* Robert B., M.A., D.Sc., F.R.S.E., F.G.S., (Pres. B, 1913), P.O. Box 1176, Johannesburg.

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